POWER

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# Responsibility

THERE was a position open.

The company had prospered and grown and now had absorbed another plant.

The Chief Engineer had come to it when both he and it were of not much account. He not only had been faithful in small things, but had expanded with the business into a knowledge and control of the larger.

He had worked with his head as well as with his hands. He had caught up and kept up with the development of engineering. He had kept himself informed of the possibilities of new ideas and apparatus and studied their application to the growing demands of his department.

His ideas had found favor with the management. They had proved good. He was consulted with regard to improvements and enlargements, and when the new plant in another city was taken over, he was made Superintendent of Power for the company and put in responsible charge of both plants.

The division of his time between the two factories made it necessary that he should have an assistant.

The engineer-in-charge at the newly acquired plant had not made a conspicuous success of it, looked upon him as an interloper and did not respond to his advances toward discussion of possible improvements with that intelligent comprehension and willing interest that promised successful co-operation.

The next most logical man for the position was one upon whom he had depended for assistance in his own plant. This man had helped him in keeping his records and in carrying out his ideas, but he never had an idea of his own. He was a good dependable workman, and when told what to do and how to do it, would come back with an accurate finished job, but he might not know what it all meant. He was a good hand to work under direction, but did not invite, and even shrank from, responsibility. He could never run the job when the chief was away, or train for succession to it when the chief got through.

And so, much as the management disliked to do it, they had to hire an outsider for this promising position simply because there was nobody in their own force who had qualified himself to assume responsibility.

F. R. Low

# Suggestions for Safe Erection of Power-Plant Equipment

By N. L. REA
Contract Service Department, General Electric Company

HEMP rope, wire rope and chains are used for handling power plant equipment, and upon their proper care and use depends not only the safety of the equipment, but also that of those doing the erecting work. In this article the author, an experienced erecting engineer, sets forth some of the things to do and some of the things not to do in handling machinery.

AWAY back in the past, prehistoric man began to be a rigger. Cord was made from pliable roots, bits of grapevine, bark or strips of rawhide. experience taught him to braid or twist small strands together to make larger cords, and cords were twisted to make rope. Certain it is that rope making was highly developed in the time of the Pharaohs, for sculpture in the tombs shows rope walks in use. Long strands of leather were cut from a skin by turning it round and round. The rope maker had a kind of swivel attached to a strap around his waist. This had a weight, used as a handle to twist the rope, and by its weight to prevent the rope from untwisting. An assistant arranged the strands as the work progressed.

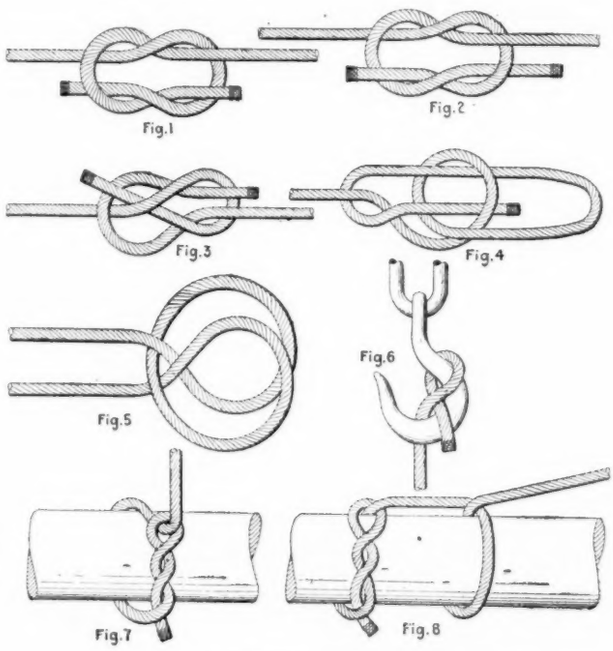
Practically the same methods were used later to make rope from cotton, flax or hemp. The fibers were spun or twisted into a yarn, this yarn being twisted in a direction called "right-hand." From 20 to 80 of these yarns, depending on the size of the rope, were put together and twisted in the opposite direction, or "left-hand," into a strand. Three or four of these strands were put together and twisted "right-hand" into the finished rope.

When a strand is twisted it untwists, to some extent, each of its component threads, and when the rope is twisted it untwists the strands but again twists up the threads. These opposite twists of the threads and strands keep the rope in its proper shape. When a weight is hung on the end of a rope the rope untwists and becomes longer, but this twists the threads tighter and the weight will revolve until the stress of the untwisting strands just equals the resistance of the threads to being twisted tighter. It is impossible to balance these two forces exactly in making rope, hence the necessity of taking out the "turns" in a new rope.

The old timers found that rope wore out and was easily damaged or cut, so it was natural to turn to chain as soon as the art of metal work developed. Chain, like hemp rope, had its faults, so wire rope came into use. The present-day rigger has three materials at his disposal—hemp rope, chain, and wire rope.

Hemp rope is easily handled and probably is the safest thing in the hands of the average workman. It can be spliced and the various standard knots are easily learned. The rope gives ample warning of decreasing strength due to wear or misuse.

The continual bending and twisting of the rope with changes of load break and destroy the fibers. These broken fibers give an indication of the amount of wear and the condition of the rope. The strands should be opened for inspection occasionally, especially when rope has continuous use. Rope drives may look fairly good on the outside when many of the internal fibers are reduced practically to dust from the continual bending and working of the fibers over one another. Proper




*Figs. 1 to 8—Knots and hitches used in handling equipment*

"stoppering" the rope and avoiding sharp bends will prolong its life greatly. Keeping rope dry and drying it promptly after a wetting is also a help.

## Kinds of Knots and Their Use

There are a multitude of knots, but only a few are necessary for the average rigging job. The principle of a knot is that no two parts of the rope that would move in the same direction, if the knot should slip, should lay alongside and touching each other. This is well illustrated in the old stand-by, the square or reef knot, shown in Fig. 1. This knot will not slip, but it is difficult to untie, especially when a heavy strain is taken on a large rope. Experienced riggers put a good-sized stick through the knot; this gives a little slack when it is pulled out and the knot comes apart readily. This knot must not be mistaken for the "granny,"

which slips under strain, Fig. 2. The same piece of rope must enter the knot and come out on the same side, as in Fig. 1. I find that the sheet bend, or weaver's knot, shown in Fig. 3, is much handier than the square knot and can be easily untied. It, however, has to be watched as the strain comes on or the bend may drop down over the loop and the end pull out.

The bowline shown in Fig. 4 is one of the best knots and may be put to many uses. The clove hitch, Fig. 5, is handy and can be thrown in the bight of a long sling. It grips well on smooth surfaces and can be used around a shaft when two slings are spread out to lift a horizontal shaft.

The Blackwall hitch, Fig. 6, is much used in hauling cars on the level, dragging material along the floor or where the length of hitch must be changed quickly. It must be used with judgment, however, as it may come undone if given any slack.

Years ago I butted in on a fellow foreman and questioned its use. He was unloading a long section of heavy steel penstock from a flat car by rolling it down skids to the ground. A heavy rope was wrapped several times around the middle of the pipe. The lower end was secured to the car and the other taken off the top of the pipe to a block and fall, the tag rope of the falls going to the snubbing post. The idea was to roll the pipe on to the skids by jacks and then ease it down by the rope and falls. The large rope was secured to the falls by a Blackwall hitch.

Says I, "Joe, that catspaw doesn't look good to me; if you get any slack you'll lose it and you will be in trouble. You ought to have a bowline." Says he, "That's plenty good enough and I always use it."

A few minutes later the pipe teetered as it balanced on the edge of the car, a wave ran along the rope and the hitch whipped off the hook. The pipe landed in the tailrace in several feet of water, entailing a week's extra work.

The timber hitch, Fig. 7, is useful in handling rough lumber such as staying planks, etc. If, however, the pieces have to be lifted end on, the timber and half hitches should be combined as shown in Fig. 8.

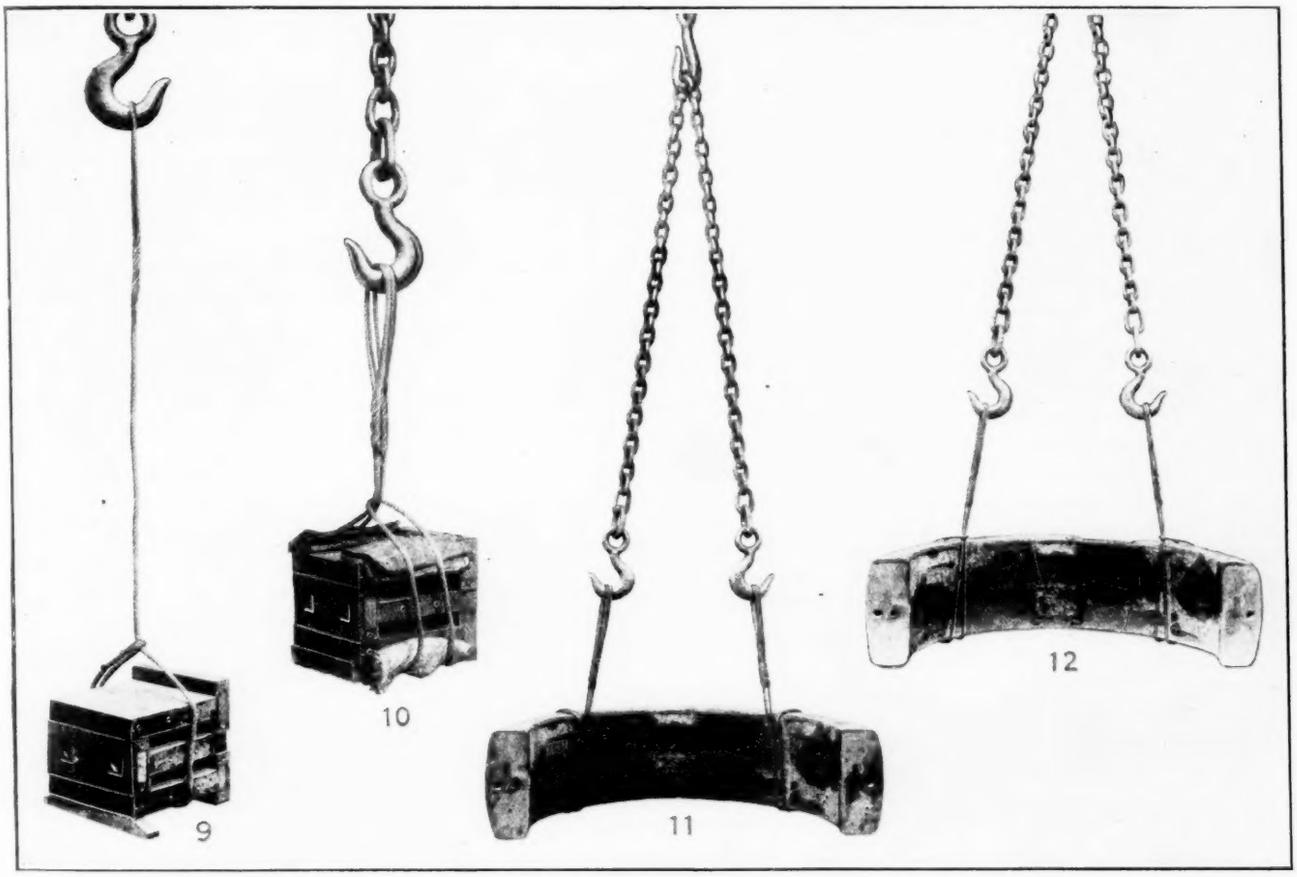
### Wire-Cable Slings

Wire-cable slings are satisfactory when properly used. It should be remembered, however, that the characteristics of wire rope are somewhat different from those of hemp rope and the proper allowances should be made. Some of the points to be looked after are:

1. Never suspend a heavy piece with a single sling as in Fig. 9, for the weight will revolve and untwist the cable enough to let the ends of the splice pull out. Use the arrangement shown in Fig. 10.

2. Wire rope is stiff, and care must be taken to divide the load carefully among the parts of the slings. One turn may bind the others and prevent them from taking their proper share of the load. It is possible to hitch on a casting with a double sling so that one strand of the sling takes all the load.

3. Avoid sharp bends in wire cables. Fig. 11 shows a hitch that reduces the strength of the sling to practically a single cable due to sharp bends and the loop

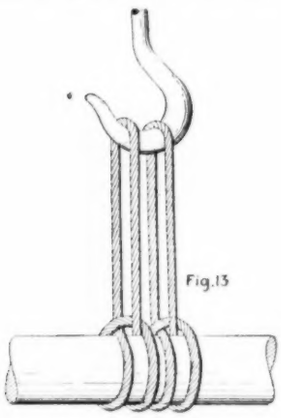


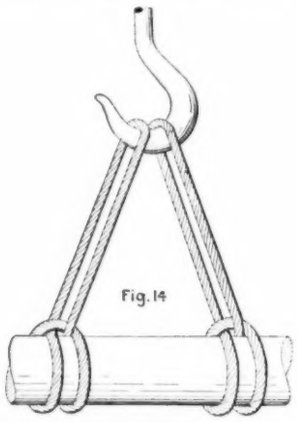

*Figs. 9 to 12—Wrong and right ways to use slings in lifting machinery parts*

in the sling. Fig. 12 shows the proper way of making this kind of hitch. The friction around the casting gives practically a two-part cable.

4. Always "stopper" the cables on all sharp corners to prevent knicking or cutting (see Fig. 10). Stoppers can be made of pieces of scrap leather or rubber belting, old canvas, a piece of boiler plate bent to fit around sharp corners or even a block of wood or a piece of plank.

5. Keep slings dry to prevent internal rusting. If the slings are held for occasional use in a power house,




*Figs. 13 and 14—Wrong and right way to use two slings for the same kind of hitch*

they should be oiled with an approved wire-rope lubricating oil and stored in a dry place.

6. A sling that shows "red rust dust" along its length or is "fussy" from broken strands should never be used on important work or when there is a chance of injuring anyone. The scrap heap is the best place for all such.

7. Do not use two or more slings in parallel on a lift. It is almost impossible to get them of exactly the same length, and the shortest sling will carry the greater part if not all of the load. Fig. 13 shows the wrong and Fig. 14 the right way to use two slings for this kind of hitch.

8. The loops in the ends of the slings should be large enough to go easily over the crane hook. Generally, an 18-in. loop is about the minimum size and 24-in. is large enough for the larger cables. The splices should be made by competent men. Avoid the use of Crosby clips for permanent slings. If they are used, they should be properly applied and securely tightened. The U-bolt of all clips should be on the dead end of the rope, as in Fig. 15. Do not stagger them, as in Fig. 16, or apply the U-bolt to the live side of the rope, as in Fig. 17. To be a successful rigger a man must above all have good judgment, or what is sometimes called horse sense; a knowledge of the strength of ropes, wire cables and chain; and be able to estimate roughly the weight of the apparatus he is called on to handle.

## Safe Loads on Ropes and Chains

The following table gives the safe loads that may be put on manila rope, wire rope and chains. The first column gives the diameter of the rope or chain; the second column the safe load which the rope or chain is to carry singly as in Fig. 18. In a sling in which the strain is carried by two ropes or chains, Fig. 19, loads given in the third column may be taken. With a sling in which four parts of the rope or chain carry the load, as in Fig. 20, if the angle between the two slings is small, the figures given in the fourth column may be used. The loads for manila rope should be used only when the rope is in fairly good condition. When badly chafed or worn, the load should be reduced in proportion. Rope slings should always be protected from sharp or rough edges on castings.

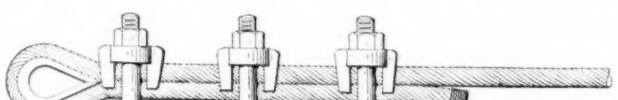
LOADS THAT MAY BE SAFELY LIFTED WITH CABLES AND CHAINS

| Dia. of Rope or Chain in In. | *Safe Load in Tons — Manila Rope — Single Rope | Two Part | Four Part | — Wire Rope — Single Rope | Two Part | Four Part | — Chain — Single Chain | Two Part | Four Part |
|---|---|---|---|---|---|---|---|---|---|
| $\frac{1}{4}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $\frac{1}{3}$ | 1 | 2 | $3\frac{1}{2}$ | $\frac{1}{4}$ | $\frac{7}{8}$ | $1\frac{1}{2}$ |
| $\frac{5}{16}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $\frac{1}{3}$ | $1\frac{3}{4}$ | $3\frac{1}{2}$ | $6\frac{1}{2}$ | 1 | $1\frac{3}{4}$ | 3 |
| $\frac{3}{8}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $\frac{1}{3}$ | $2\frac{1}{2}$ | $4\frac{1}{2}$ | 9 | 2 | $3\frac{1}{2}$ | 6 |
| $\frac{7}{16}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{4}$ | $3\frac{1}{4}$ | 6 | 12 | 3 | 5 | 9 |
| $\frac{1}{2}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{2}$ | 4 | 8 | 16 | 5 | 9 | 15 |
| $\frac{9}{16}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{2}$ | $4\frac{1}{2}$ | 9 | 18 | 6 | $10\frac{1}{2}$ | 18 |
| $\frac{5}{8}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{2}$ | 5 | 10 | 20 | 8 | 14 | 24 |
| $\frac{3}{4}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{2}$ | 6 | 12 | 24 | 8 | 14 | 24 |
| $\frac{7}{8}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{2}$ | $6\frac{1}{2}$ | 13 | 26 | 9 | 16 | 27 |
| 1 | $\frac{1}{8}$ | $\frac{1}{4}$ | $1\frac{1}{2}$ | 7 | 14 | 28 | 10 | 18 | 30 |
| $1\frac{1}{4}$ | .. | .. | .. | ... | ... | ... | 6 | $10\frac{1}{2}$ | 18 |
| $1\frac{1}{2}$ | 1 | 2 | 3 | 6 | 12 | 24 | 8 | 14 | 24 |
| $1\frac{3}{4}$ | $1\frac{1}{4}$ | $2\frac{1}{2}$ | 4 | 10 | 19 | 36 | 11 | 19 | 33 |
| $1\frac{3}{4}$ | 2 | 4 | 6 | 13 | 25 | 48 | 13 | 23 | 39 |
| 2 | $2\frac{1}{2}$ | 5 | 8 | 16 | 32 | 60 | 18 | 32 | 54 |
| $2\frac{1}{4}$ | $3\frac{1}{2}$ | $6\frac{1}{2}$ | 11 | | | | | | |
| $2\frac{1}{2}$ | $4\frac{1}{2}$ | 8 | 14 | ... | ... | ... | ... | ... | ... |

* Figures are in tons of 2,000 lb. each.

The figures in the table have a considerable margin of safety and are intended for slings in constant service. They are in general considerably under the "safe working loads" given by the manufacturer of cordage, wire rope and chains. Where very large and heavy pieces are being handled during installation, cables may be used a very few times and the cost of slings may be considerable. In these cases the rated loading given by the manufacturer may safely be used or slightly exceeded in an emergency. However, if this is done it is advisable to have a special set of slings made for this particular part of the job and used for nothing else.

For instance, a pair of slings should be furnished for handling a 100- or 200-ton revolving field and kept



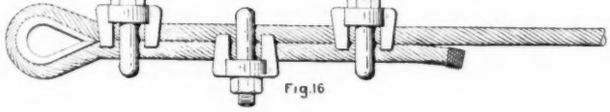


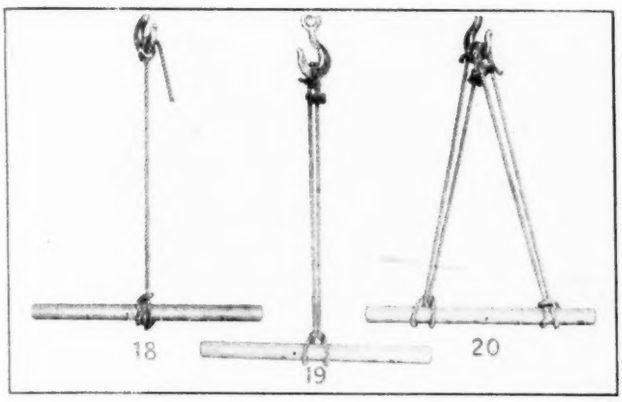

*Fig. 15—Correct way; and Figs. 16 and 17, incorrect ways of using Crosby clips on wire rope*

in "cotton batting," so to speak, between lifts. Locking them up is the only safe way. I found one of a pair of 60-ft., $1\frac{1}{4}$-in. wire-cable slings being used to fish timber out of a wheel pit one morning. The fact that the pair arrived the night before by express to handle the large armature meant nothing in the young life of the man who was told to clear the pit. They were handy and long enough with a lovely eye in either end. He should worry if they got kinked and soaking wet.

## Sudden Stoppages of Load

Before handling heavy loads with a crane, the crane should always be tested to see that the brakes will hold, and care must be used when lowering loads to limit

the speed of lowering, which generally should not exceed the hoisting speed of the crane for the same load, particular care being taken to apply the brakes gradually when bringing the load to rest in descending. The ordinary hoisting speed for a 30-ton motor-operated crane is about 18 ft. per min., and for a 50-ton crane about 12 ft. per min. with the rated load. Stopping the rated load at such speeds within a distance of about ½ in. may double the stress on the slings and crane.




*Figs. 18 to 20—Methods of lifting loads referred to in the table*

This is on the assumption that the crane is lowering at its full speed and then the power is suddenly thrown off and brakes quickly applied so as to stop the load. I have seen this done when one could see the crane girders and building steel spring up and down and vibrate several times before coming to rest.

A second article will discuss the increased stresses due to the angle of the slings, the use of chains and safe loads for eyebolts.

## Condenser Efficiency

BY FRANK R. WHEELER

There are several expressions for condenser efficiency in the literature on the subject, but the writer has found none that bears a thermodynamic analysis. The heat input into a condenser is the product of the pounds of steam per hour and the heat in B.t.u. per pound, or, $W \times L$, where W is the pounds of steam per hour and $L$ the B.t.u. per pound of steam.

Since a condenser is an apparatus to effect an exchange of heat from steam to cooling water, its performance can be considered in terms of temperature differences. If the circulating, or injection, water were able to absorb a maximum quantity of heat, it would leave the condenser at the same temperature as the entering steam and the temperature rise would be $T_s - T_1$, where $T_s$ is the temperature of steam entering condenser, $T_1$ the temperature of water entering condenser and $T_2$ the temperature of water leaving the condenser.

This means that the water leaves the condenser at the same temperature as the incoming steam and that no more heat can be absorbed, or that the steam temperature (and consequently its corresponding pressure, or vacuum) is reduced to the temperature of the leaving water.

Actually, the water leaves the condenser at some temperature, $T_2$, less than the incoming steam temperature, $T_s$, and with a loss in possible heat absorbed $T_2 - T_1$ degrees. The efficiency of a heat-transfer apparatus is

$$\frac{Actual\ heat\ exchanged}{Possible\ heat\ exchanged}$$

Since temperature changes in condenser cooling water represent heat changes, the foregoing can be expressed as follows:

$$\frac{Actual\ temperature\ rise\ of\ circulating\ water}{Possible\ temperature\ rise\ of\ circulating\ water} \text{ or } \frac{(T_s - T_1) - (T_s - T_2)}{(T_s - T_1)}$$

Clearing and multiplying by 100 to express the result in per cent gives,

$$Efficiency = \frac{T_2 - T_1}{T_s - T_1} \times 100$$

It is evident that the formula last given is a true expression of efficiency of heat exchange, for if $T_2 = T_s$, there is a ratio of unity, or 100 per cent efficiency. If no steam is being condensed, then $T_2 = T_1$ and the result is zero efficiency.

It has been usual to judge the performance of surface condensers by the calculated heat-transfer coefficient.

CONDENSER EFFICIENCIES FROM PUBLISHED TESTS

| Operating Co. Generating Station | Vacuum, Ref. 30 in. | Temp. Vacuum, $T_s$ | Temp. Water in, $T_1$ | Temp. Water Out, $T_2$ | Heat Transfer | Efficiency | Source of Data |
|---|---|---|---|---|---|---|---|
| Louisville G. & E. Co., Waterside | 29.8 | 82.06 | 40 | 49 | 206 | 21.6 | |
| Waterside | 28.30 | 97.76 | 72 | 84 | 395 | 43.2 | |
| Adirondack L. & P. Co., Amsterdam | 29.10 | 75.90 | 44 | 58 | 262 | 43.9 | |
| Beach Bottom Pwr. Co., Windsor | 29.11 | 75.8 | 32 | 45 | 182 | 31.4 | N.E.L.A. |
| | 28.22 | 97.6 | 73 | 88 | 418 | 61.0 | Condenser |
| N. Y. Edison Co., Waterside No. 1 (W. C. & E.) | 29.11 | 75.9 | 57.9 | 64.7 | 522 | 37.8 | Report No. |
| | 28.77 | 85.4 | 55.7 | 68.6 | 575 | 46.3 | 25-98 Table 2 |
| N. Y. Edison Co., Waterside No. 1 (I.R.) | 29.28 | 69.2 | 48.3 | 55 | 423 | 34.9 | |
| | 29.98 | 79.8 | 49.4 | 60.3 | 512 | 35.8 | |
| San Joaquin L. & P. Co., Midway | 26.1 | 124.5 | 80 | 98 | 450 | 40.4 | |
| Northern States Pwr. Co., Highbridge | 29.16 | 74.0 | 34 | 44 | 148 | 25.0 | |
| Toledo Edison Co. | 29.02 | 78.4 | 64 | 71 | 637 | 48.5 | Trade Catalog |
| Detroit Edison Co., B-1-2 & 7 | 28.61 | 88.1 | 67.2 | 79.3 | 445 | 58.0 | |
| Detroit Edison Co., Unit C-2-28 | 28.28 | 95.6 | 69.1 | 76.3 | 458 | 26.8 | Chatel paper A.S.M.E. Dec., 1926 |
| Detroit Edison Co., Unit C-2-73 | 29.17 | 74.9 | 32.6 | 39.3 | 342 | 16.2 | |
| Detroit Edison Co., Unit D-1-58 | 28.37 | 94.4 | 72.5 | 80.8 | 430 | 37.9 | |
| City of Lansing | 28.53 | 89.0 | 69.0 | 83.1 | 480 | 70.5 | *Power* -127-25 & J. |
| City of Lansing | 28.96 | 80.8 | 69.9 | 77.2 | 435 | 67.0 | E. Woodwell |
| Broad River | ..... | ..... | ..... | ..... | ... | 67.0 | Bancel paper |
| Pasadena, Calif. | ..... | ..... | ..... | ..... | ... | 55.0 | A.S.M.E. Dec., 1926 |
| Manchester, England, Barton | 29.35 | 66.5 | 46.3 | 56.3 | 423 | 49.6 | *Engineering* 2-26-26, |

It is interesting to notice the variations in heat-exchange efficiencies as compared with heat transfers by a comparison of the several published tests given in the accompanying table.

It should be added that true comparisons should be made at rated capacities, and also remembered that, owing to the known improvement in heat transfer with warm water as compared with cold, and with high velocities, better efficiencies are to be expected with the more favorable operating conditions. The per cent load also affects the heat-exchange efficiency.

The general expression $\frac{T_2 - T_1}{T_s - T_1}$ applies to jet condensers and all heat exchanges of similar character.

# Why Boiler Tubes Blow Out

By J. M. BRENNAN

IN MODERN power-plant practice the operation of water-tube boilers at high ratings has, under certain conditions, caused much trouble from blowouts. These ordinarily occur in the first row of tubes, where the water-heating surface is exposed to the highest temperature and to flame impingement. The greatest rate of steam generation takes place in these tubes, so that any cause tending to restrict the transfer of the furnace heat from metal to water, is likely to result in bulging and finally in a rupture.

Ruptures may also result from internal local corrosion, which thins the wall of the tube. This apparently takes place whether or not scale is present. In some cases the blowout occurs without any undue heating of the tube metal.

**BOILER-TUBE blowouts are a serious problem in many plants, particularly with oil-burning boilers. The cause of such blowouts has been a matter of much dispute. Some say that tubes absolutly free from scale cannot blow out. Others offer evidence to the contrary. The thinning of the tube at the point of blowout has also been the subject of much argument, some claiming that corrosion proceeds on the water side of the tube, others that it takes place on the fire side. The author has investigated many tube blowouts and presents here his understanding of what takes place. What he has to say will interest those engineers who are face to face with this pressing problem.**

Amelioration of the trouble has been attempted, sometimes with fair success, by different investigators. They have advanced various theories as to the cause, which may be itemized as follows:

External Causes: (1) Impingement of furnace flame; (2) slow distillation of the tube metal by impregnation with the fuel oil; (3) corrosion of the external side of the tube by sulphuric acid, formed by the combination moisture and the combustion products of the sulphur in the oil used.

Internal Causes: (1) Scale-forming feed water; (2) grease on tubes; (3) steam locking or reverse of water flow; (4) corrosive feed water; (5) segregation of the tube metal.

Reviewing these various issues, the following notations are based on the writer's observations made where such conditions existed.

## External Causes

1. Impingement of the flame, producing a dry tube wall because of a too rapid localized evaporation, is very unusual and occurs only with fuel-oil burners. Experience has shown that when the furnaces are sufficiently deep, the burners properly arranged and adjusted and the proper care given to the tips, this action does not cause any trouble.

2. Slow distillation of the metal, or an oxidizing destruction by impregnation with the carbon residues of fuel oil depositing on the tube, is highly improbable. The high temperature in oil-burning furnaces prevents any carbon deposit on the fire side of the lower tubes. If any coke deposit should occur on the upper side, it would have little effect. In Scotch-marine boilers where the flame strikes directly against the $\frac{3}{8}$-in. metal of the Morrison tubes, no trouble occurs when the water side is clean.

It is possible, however, for this phenomenon to occur if heat flow from the tube to the water is so restricted that the metal reaches a high temperature. This can be caused by grease, corrosive layers, or scale of sufficient denseness, even though extremely thin. Under any one of these conditions damage to the outside of the tube occurs, forming a metallic scale similar to a crucible blister. This type of trouble produces very rapid destruction when once started.

3. Corrosion of the tube on the outside by sulphuric acid, formed from the gaseous combustion products, is practically impossible in the first rows of tubes, where the intensity of the furnace heat should prevent condensation of the acid. In the later passes of the boiler, due to leaky tubes or to blower steam mixing with the soot, corrosive action on the outside surface of the tubes will occur when boilers are not to be operated for a period, or when they are used on standby service, particularly in damp weather, the fire side of the tube should be cleaned. The reason is that if soot and ashes are allowed to cool with the tubes, they may form a scale which cannot be removed without wire brushes and metal scrapers. The fluffy deposit that clings to the tubes in oil-burning furnaces also carries sulphur. When a boiler is shut down, any leaks will dampen the solid deposits, which will then become corrosive.

## Internal Causes

1 and 2. Scale or grease deposit in the tube is a prolific cause of tube failures because any condition that will permit the tube to reach a high temperature will cause bulging and a blowout. Transient scale, that is, a scale that will redissolve in the boiler when the temperature is lowered (as for instance when a boiler is standing by), is very elusive. If the boiler is opened after it has cooled down, no scale can be seen. Floating fragments, even though of eggshell thickness, can be redeposited in several successive layers, causing a local hot spot. At this point overheating will take place, leading eventually to bursting of the tubes.

3. The possibility of local overheating caused by the formation of steam bubbles on the under side of the tube is remote. The greater the rating of the boiler, the greater is the velocity of the water through the tubes.

Since the generation of steam is greatest in the first row, the velocity is highest there. It is evident, therefore, that steam bubbles should be more quickly swept away. Moreover, these bubbles have an additional tendency to rise from the under side, due to the joint action of gravitation and currents in the water.

The reversal of flow in the boiler tubes and locking of a pocket of steam, which might leave the surface

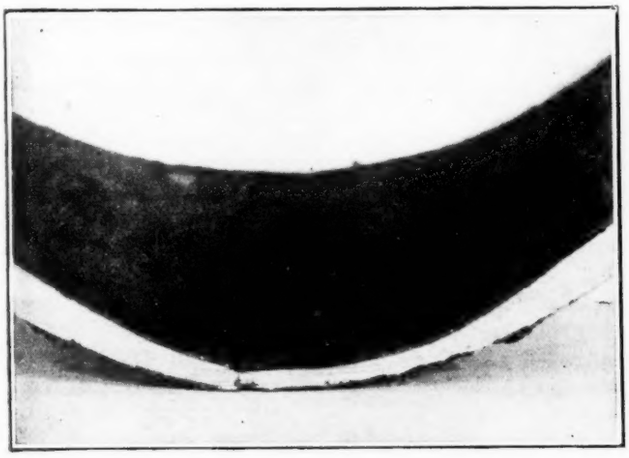


*Fig. 1—This tube, operated without scale, shows wasting away of metal on inside*

intermittently dry, is a somewhat obscure phenomenon. It is a question whether any such action takes place.

It is claimed that, with Stirling-type boilers, there is sometimes a spasmodic ejection of the steam, so that the tubes are not continuously wet. If such a condition is suspected, the concentration of flame at the lower end of the front tubes should be deflected by a new design of wall.

4. Corrosive feed water is a potential factor in causing tube blowouts. The deposit, formed at the expense of the tube metal, causes gradual thinning. Corrosion products accelerate oxidizing. Being much poorer conductors of heat than the tube metal, they give rise to hot spots even when the tube is free from scale deposits.[1]

5. While those investigating tubes have given much thought to the treatment of the water before entering the boiler and within the boiler, little study has been made of the structure of the tube metal. Unfortunately, until very recently metals that are known to resist corrosion have not been obtainable in boiler tubes, owing to the greatly increased cost and difficulty of manufacture.

### Tube Metal Should Be Homogeneous

Recent investigators have found that segregations of the interior wall of tubes are a direct cause of internal local corrosion and tube blowouts. It has been found that sulphur prints taken from tubes selected at random showed the interior badly segregated. The belief is that these defects are due to pockets in the original ingots from which the steel was rolled. Rapid failure of tubes by corrosive feed water and the electrolytic action of metallic scales, segregates and blow holes, should be thoroughly investigated where blowouts occur in clean tubes.

It seems that the usual water tests for alkalinity and acidity are not quite adequate for the definite control of corrosion. Titration does not give any measure of the actual corrosiveness. On the other hand, the hydrogen-ion concentration[2] can be exactly regulated to the point where the smallest amount of corrosion takes place, with the addition of the least amount of alkali.

One large plant with the Stirling-type boiler used both steam and mechanical atomization for the fuel-oil burners. With the steam-atomizing type of boilers, failures increased at high ratings. The cause in every case was dirty tubes. Similar boilers at similar ratings showed more tube blowouts with mechanical atomization.

### Water Treatment Often Solves Difficulty

After a thorough study of a record kept for a long period, it was found that when the front row of tubes was renewed no blowouts occurred until the new tubes had been in long enough to acquire a coating of scale. After each cleaning the blowouts diminished for a short time and then gradually increased up to the time of the next cleaning. Chemical treatment was then tried until finally a condition was brought about which left the tubes scale free. Thereupon the trouble ceased.

In a plant in which there were horizontal water-tube boilers, equipped with mechanical atomization, rapid burn-outs were laid to flame impingement and operation at too high ratings. As these boilers had been changed from steam atomization, where the trouble even at high

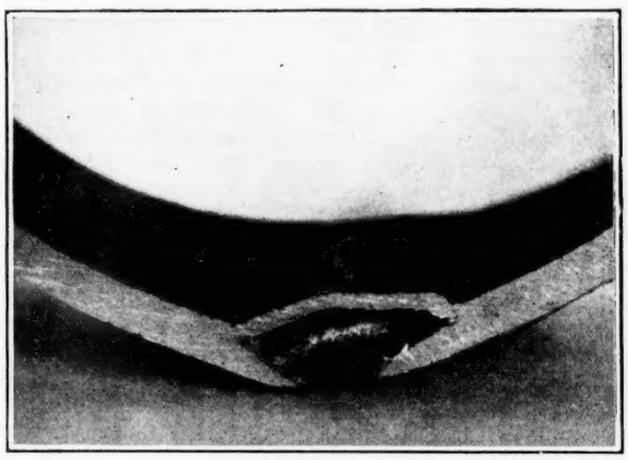


*Fig. 2—An extreme example of segregation. Heat resisting material in pocket resulted in burning of metal. This pocket happened to be due to a poor lap weld*

ratings was slight, the new burner arrangement was suspected. But when the old scale was removed and chemical treatment was applied to keep the tubes clean it was found (even when operating at a continuous high rating) that the tubes ceased to bulge and blow out.

In a small industrial plant, severe surface corrosion

[1] In some cases the velocity of water through the tubes is sufficient to sweep the corrosion residue away, giving corrosive feed water a better chance to attack the metal and hasten the destruction. The inside surface of such a tube will be found to be perfectly smooth and clean and thinned down at the blowout location.

[2] Stated simply, hydrogen-ion concentration is a definite measure of the actual "acidity" of a solution, regardless of what acids or alkalis it may contain. It may easily be determined by apparatus already on the market. Little chemical training or theoretical knowledge is necessary in order to use this control in practice.

of the boilers existed. No scale or local thinning could be found. An extensive investigation showed improper operation of the open feed heater and proved that corrosive substances from process work were finding their way into the returns and back into the water. The various disturbing conditions were gradually alleviated and a chemical treatment applied to the boiler water to assist in checking the corrosion. As a result the difficulty ceased.

In some other boiler plants where blowouts occurred, an examination of boilers and sections of tubes cut open showed the surfaces to be clean. In one such case the

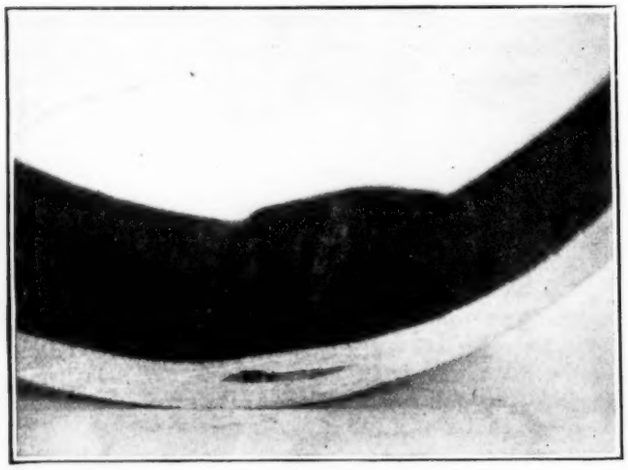


*Fig. 3—Other end of specimen pictured in Fig. 2, showing some segregations hermetically sealed by the tube metal*

cause of tube blowouts was found to be an internal corrosion of the tube.

In the study of tube burning, as has been before mentioned, oil-fired furnaces were found to give the most trouble when mechanical atomization was used. Extended researches showed that the heat in the lower part of the furnace was more concentrated with mechanical atomization.

In studying the cases of internal corrosion, it is difficult to arrive at a conclusion that applies as a general rule, the cause usually being some local condition. If the types of tubes are studied and a record kept of the service of different types, and if both the feed water and the boiler water are kept free of scale forming and corrosive tendencies, it is believed that boilers can be operated at high ratings without any tube-blow difficulties. A bad stock of tubes might bring about a condition that would be very difficult to cope with, and therefore, before making any radical change in chemical treatment, it would be well to examine the metal of the tubes for flaws or segregations.

It might be advisable to use corrosion-resisting metal in the tubes next the furnace. Otherwise the mill scale should be removed by pickling or sandblasting to prevent pitting and corrosion.

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A WATER-COOLED, OIL-INSULATED TRANSFORMER should not be operated with the cooling water shut off; even without load the losses in the iron and windings are sufficient to cause the temperature to rise above the danger point.

## Oil Engines Wear Most When Idle

BY R. C. SHOOK

Strange as it may appear, the statement that oil engines frequently show more wear when idle than when operating is in a measure true. A more accurate statement probably would be that conditions brought into existence by idle periods cause more wear than operating conditions.

In many oil-engine power plants, especially those of large capacity, an extra unit is installed, thus allowing full capacity of uninterrupted service when a shutdown for periodical inspection or repairs is required. It is the usual practice in plants of this type to run a certain period, for example, about two weeks, and then switch the load of one of the engines to the stand-by. This is supposed to keep the wear or age of all the units the same.

Often there are no repairs required to be done on the engine during its idle period, and very seldom is it necessary to open up the engine or pull a piston. Even when this is done, it is usually as soon as the engine has cooled enough to permit working on it. If, however, the engine is allowed to stand for several days before the cylinder head is removed, a thin coating of rust will be found on the cylinder walls. While this rust is not enough to affect the starting or running of the engine directly, it cuts down the life of the cylinder liner. The rust formed each time the engine is idle, is rubbed off during the first few revolutions, thus causing a greater cylinder wear than would really be the case if the wear on the walls were due only to piston-ring friction.

The formation of this iron oxide, or rust, during the idle period is due, in great part, to the moisture in the atmosphere and to the hydrogen and oxygen present as superheated steam in the burned gases in the cylinders, condensing on the cold cylinder walls. In cases where the fuel being used has a high sulphur content, the rusting will be more pronounced as the sulphur in the burned gases will combine with the moisture on the walls of the cylinder, forming sulphuric or sulphurous acid, which will readily attract the iron.

Some engineers, trying to prevent this corroding, overfeed the cylinders with lubricating oil to leave an oil film as protection before shutting down. While this is a step in the right direction, it is not the best solution of the problem, as most of the oil film on the upper part of the cylinder is burned off during the combustion strokes.

In order to prevent this burning of the lubricating oil film, the flushing should be done after the engine is shut down, and this may be done in either of the following ways: (a) Run the engine for several revolutions on starting air; (b) turn the engine over for several revolutions with the jacking gear. In both methods, of course, the lubricator must be set for overfeeding.

The former method is not only easier for the engineer, but has the advantage of blowing out the burnt gas almost entirely. While the second method will not clean out the cylinder as well as the first-mentioned, it is often found desirable as a means of conserving the starting air in plants where the supply is close to the minimum requirements and where the compressor is small.

# How a Two-Speed A.-C. Elevator Controller Operates

## Circuits and Adjustments of an Alternating-Current Type of Controller Used with a Two-Speed Squirrel-Cage Motor, Having a Speed Ratio of One to Three

BY CHARLES A. ARMSTRONG

FOR the elevator operator to make a good landing, it is necessary that the speed of the car be decreased to about 75 ft. per minute before centering the car switch. With direct-current equipment the control can be easily arranged for slowing down the motor. On modern alternating-current elevators squirrel-cage motors are used almost exclusively, and these motors

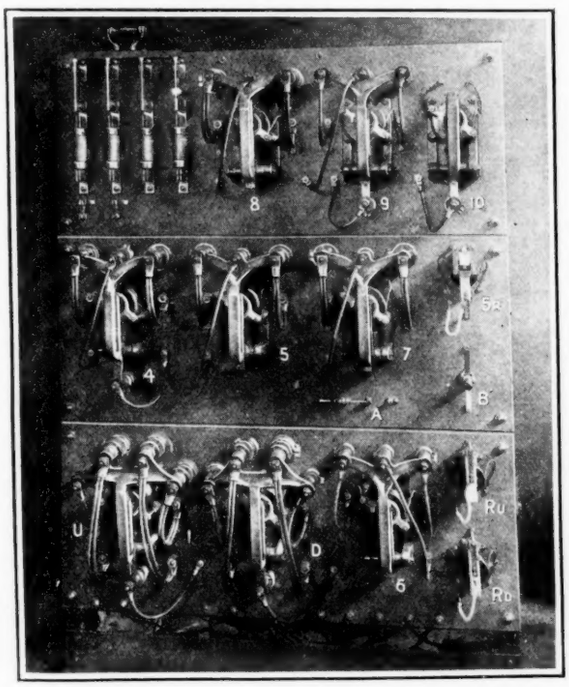


*Fig. 1—Controller for two-speed squirrel-cage induction motor*

Contactors *U* and *D* are the direction switches; contactor 4 short-circuits to high-speed motor winding; contactor 5 short-circuits the low-speed motor winding; contactor 6 short-circuits the buffer resistance; contactors 7, 8 and 9 cut out the starting resistance; relay 10 is a speed-changing interlock; relay 5*R* is a high-speed interlock; *RU* and *RD* are direction-switch interlocks; *A* is the throw-over control switch; *B* a control switch which allows operating the elevator at slow speed from the control board.

are inherently constant-speed machines. Therefore, they are limited to car speeds of 100 ft. per minute or less. For higher speed it is general practice to use two-speed squirrel-cage motors, the speed of the slow-speed motor being such as to give a satisfactory car speed for stopping the car and the high-speed motor giving the desired running car speed.

Three types of two-speed squirrel-cage motors are used. In one type, only a single winding is used and this winding is regrouped to give to different numbers of poles; for example, 12 poles on 60-cycle for a motor speed of 600 r.p.m., and 6 poles for 1,200 r.p.m. These are theoretical speeds; the actual speeds will be about 20 per cent less.

A second method of obtaining two speeds is to put two windings in the same stator core, each grouped for a different number of poles. A third method is to use two separate stators, each wound for a different number of poles. These stators are supported in a common frame, and the rotor for each is mounted on a common shaft; thus, the two machines are combined into a single unit. The last two methods allow of most any speed ratio between the two windings, where the first is practically limited to a ratio of 1 to 2. Where two separate stator windings are used, speed ratios as high as 1 to 6 have been utilized.

A Gurney Elevator Co. type No. 32-G two-speed squirrel-cage motor controller is shown in Fig. 1. What the different contactors are used for is indicated below the figure, and the operation of the controller will be made clear by a study of the wiring diagrams Figs. 2 and 3. Fig. 2 shows the wiring diagram complete for a two-phase motor as used on a traction elevator machine, and Fig. 3 is a simplified arrangement of the connections.

### How the Controller Operates

On the car switch there are five connections 1, 2, 3, 4 and 5. With the car switch closed to the slow up-direction position, the circuit is closed between points 1 and 2. This completes a circuit for the up-direction switch *U* from $L_1$ side of the line switch to the throw-over single-pole knife switch *A*, to No. 1 terminal at the bottom of the controller and to Nos. 1 and 2 on the car switch. From the car switch the circuit is back to 2 on the up-direction switch. Here the circuit divides, one branch being through coil *U* to contact 8 on the bottom of the down-direction switch and the other through coil *RU* to contact 8, hence these two coils are connected in parallel. From contact 8 the circuit is through the top hoistway limit switch 8-11 and back to 11 at the bottom of the controller and to the bottom contact on contactor No. 9, through the phase-reversal relay to contact 6 at the bottom of the controller, back to the car and through the gate, safety and emergency switches, returning to 7 at the bottom of the controller and to the $L_2$ line terminal. This circuit can be easily traced in a simplified diagram Fig. 3. Completing this circuit energizes the coil on the up-direction switch *U* and the coil on relay *RU* and causes the contactors to close.

With the up-direction switch closed, a circuit for the

stator winding is completed from the $L_1$ side of the line to the top contact of switch $U$ to 10 and to $R_9$, through all the resistance to $T_1$ and to $T_7$ on the motor, through the high-speed winding to $T_{12}$, and through the low-speed winding to $T_{13}$, back to $T_{13}$ on the up-direction switch to the $L_2$ line. The circuit on the other phase of the motor is from the $L_3$ line to $R_8$ on the starting resistance, through all this resistance to $T_2$ on the motor, through

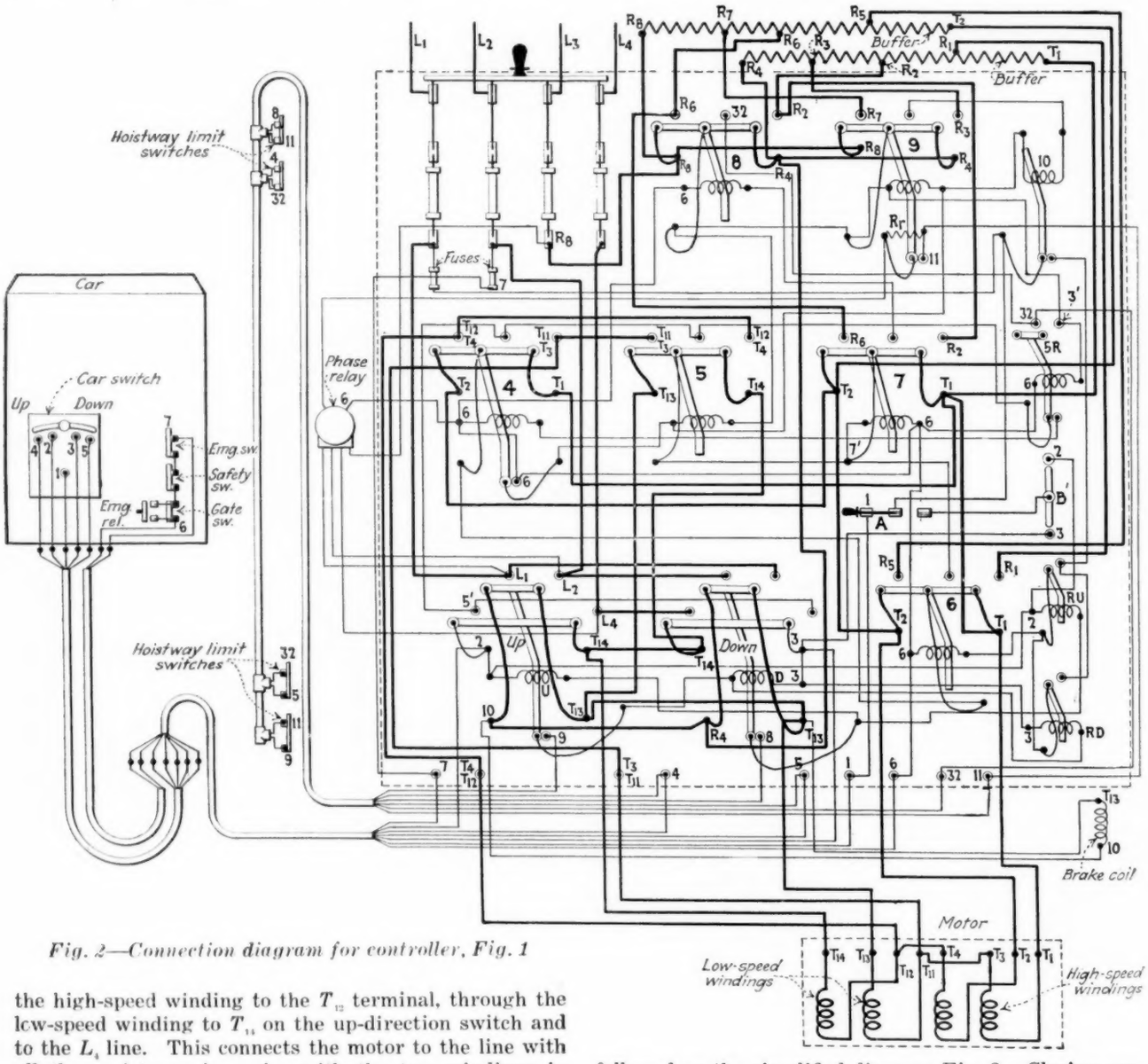


*Fig. 2—Connection diagram for controller, Fig. 1*

the high-speed winding to the $T_{12}$ terminal, through the low-speed winding to $T_{11}$ on the up-direction switch and to the $L_4$ line. This connects the motor to the line with all the resistance in series with the two windings in series.

The brake coil connects to terminal 10 on the up-direction switch and $T_{13}$ on the down-direction switch. These two terminals are energized with the closing of either direction switch and the brake is released. Referring to Fig. 3, it will be seen that the brake coil is connected directly across one of the windings of the motor and its starting resistance. This leaves the brake coil connected to the motor after it is disconnected from the line. The voltage generated in the motor windings for a short period after being disconnected from the line, helps to prevent the brake from slamming on the wheel and causing an abrupt action in stopping the car.

At the same time the up-direction switch coil was energized, the coil of relay $RU$ was energized and its contactor closed. Closing of contactor $RU$ completes the circuit for the coil of contactor 6, from $L_1$ line to the contact at the bottom of contactor 10, through $RU$ contactor, the coil on No. 6 contactor, then through the gate, safety and emergency switches in the car and returns to the $L_2$ line terminal. This circuit can be easily followed on the simplified diagram Fig. 3. Closing contactor No. 6 short-circuits the buffer resistance out of each phase of the motor, by connecting $T_1$ of one phase to $R_1$ in one resistance group and $T_2$ of the other phase to $R_9$ in the other resistance group. This contactor should be adjusted to close at practically the same time the direction switch closes, since it cuts the buffer resistance out of circuit. This resistance is not intended to control the starting of the motor, but to regulate the slowdown, from high to low speed, at stopping.

Closing of contact 5′ on the up-direction switch, completed the circuit for the coil on contactor No. 4, from 2 on the up-direction switch to 5′, through the bottom contact on relay 5$R$, through the coil on 4 contactor to 6

terminal and returns to the $L_2$ line as previously explained. When contactor No. 4 closes, its two outside contacts short-circuit the high-speed winding in each phase of the motor. On the motor it will be seen that $T_1$ and $T_3$ are the terminals of one phase of the high-speed winding and $T_2$ and $T_4$ are the terminals of the other phase. When contactor 4 closes, it connects $T_1$ to $T_3$ and $T_2$ to $T_4$, thus short-circuiting the high-speed winding. This contactor should be adjusted for rapid closing so as to cut out the high-speed winding about the time that the motor begins to move.

Closing of contactor No. 4 provides a circuit for the coil on No. 7. This circuit is from 5′ on the up-direction switch through the center contacts on Nos. 4 and 6 contactors and coil 7, to terminal 6 and to the $L_2$ line as previously explained. Closing of this contactor connects motor terminal $T_1$ to resistance terminal $R_2$ and motor terminal $T_2$ to resistance terminal $R_6$, thus short-circuiting the resistance between these two points. It will be noted that the closing of contactor No. 7 also short-circuits contactor No. 6, which closed to cut the buffer resistance out of circuit.

Contactor No. 8 is the next to close, and a circuit for its coil is made from 5′ on the up-direction switch through the center contacts on contactors Nos. 4, 6 and 7, through coil 8, to terminal 6 and to the $L_2$ side of the line. Closing of this contactor short-circuits the starting resistance between $R_2$ and $R_4$ and between $R_6$ and $R_8$. This short-circuits all the starting resistance and the motor can come up to speed on the slow-speed winding.

Moving the car switch to point 4 closes the contactors to cut the high-speed windings of the motor in and the low-speed out. The first circuit is that for relay $5R$. This circuit is from 4 on the car switch to 4 at the bottom of the panel, to the lower top limit switch in the hoistway, back to 32 contact at the top of contactor 8, through the coil of relay $5R$ to 6 and to the $L_2$ line. When this relay closes, it completes a lock circuit to hold it closed, by connecting its terminal 32 to 3′. This allows contactor 8 to open without interfering with the operation of relay $5R$.

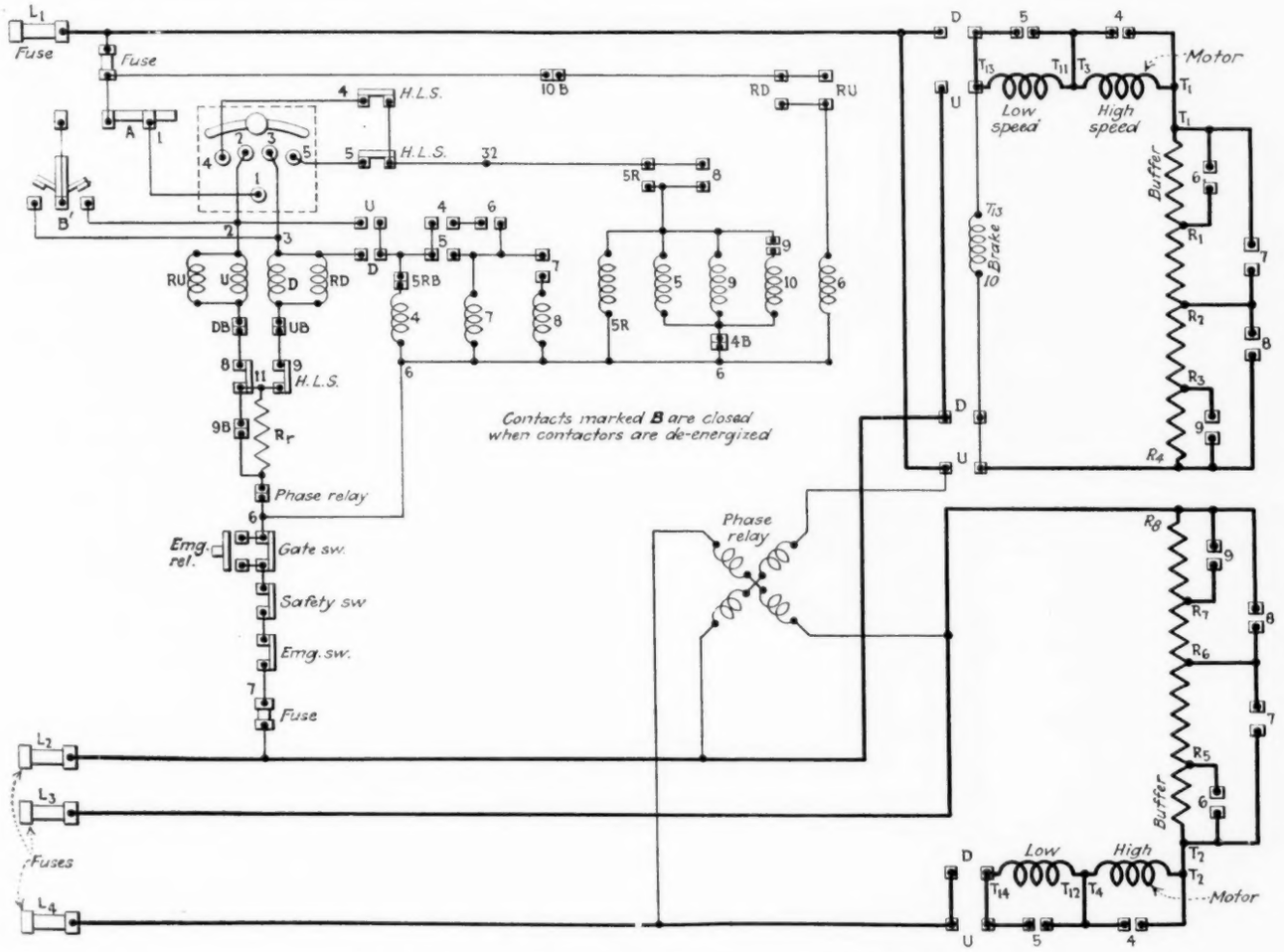


*Fig. 3—Simplified diagram of the connections, Fig. 2*

When relay $5R$ closed, it opened its bottom contact and interrupted the circuit through the coil of contactor No. 4 and caused this contactor to open. When this contactor opens, the high-speed winding is again cut into circuit along with the low-speed winding. Opening of No. 4 contactor also interrupts the circuits to the coils on contactors No. 7 and 8 and these contactors open, which places all the starting resistance back into the circuit.

No. 4 contactor, when it opened, closed its bottom contact 6, and this completed the circuit for the closing coils on contactors Nos. 5 and 9. The circuit for No. 5 coil is from 32 to 3′ contact on relay $5R$, through coil 5 to contact 6 on contactor No. 4 and to the $L_2$ line. Closing No. 5 contactor, connects $T_{12}$ terminal of the slow-

speed winding to the $T_{14}$ terminal and the $T_{11}$ terminal to the $T_{13}$ terminal, thus short-circuiting the low-speed winding.

The circuit for No. 9 coil is also from the top contacts of 5*R* relay to No. 6 contact or contactor No. 4. When No. 9 contactor closes, it short-circuits the sections of starting resistance between $R_3$ and $R_4$ and between $R_7$ and $R_8$, thus increasing the speed of the motor on the high-speed winding. Bottom contact 11 on No. 9 contactor, opened when this contactor closed and placed resistance $R_9$ in series with the coils of the up-direction switch and relay *RU*. This reduces the current in these coils to a value necessary to hold the contactors closed, and allows them to open more quickly when the coil circuits are interrupted, than if the current remained at the value necessary for closing.

A circuit for the coil on No. 7 contactor was completed when No. 5 contactor closed, from 5′ on the up-direction switch to the center top contact of No. 5 contactor, through coil 7 to terminal 6 and to the $L_2$ side of the line. Energizing of this coil causes contactor No. 7 to close and short-circuit the resistance between $T_1$ and $R_2$ and between $T_2$ and $R_6$, which further increases the speed of the motor.

The coil on No. 8 contactor is again energized, when No. 7 closes, by a circuit from terminal 7′ on contactor 7, through coil 8 to terminal 6 and the $L_2$ side of the line. When this contactor closes, it connects $R_2$ to $R_4$ and $R_6$ to $R_8$, thus cutting the remainder of the starting resistance out of circuit and allows the motor to come up to full speed.

No. 9 contactor closing, completes the circuit for the coil on relay 10. This circuit is from 32 and 3′ on relay 5*R*, through the center contacts of contactor No. 9, coil 10 to 6 terminal and the $L_2$ line. No. 10 relay has only one contact and this is normally closed. Energizing coil 10 opens this contact and interrupts the circuit to contactor No. 6. This operation causes No. 6 contactor to open and place the buffer resistance in series with the starting resistance so as to be available for slowing down the speed of the motor during the stopping operation. The buffer resistance is still cut out of the motor circuit owing to No. 7 contactor being closed.

### Adjustment of Contactors

In adjusting the closing sequence and time of closing of the contactors during acceleration on the high-speed winding, No. 5 closes first and its motion should not be retarded as it short-circuits the low-speed winding in the motor. Following the closing of No. 5, contactors Nos. 9, 7, 10 and 8 close in sequence, and all should have their motion retarded by their dashpots. In adjusting these contactors, it is necessary that No. 7 closes before No. 10 opens its contact, to prevent cutting the buffer resistance into circuit with the motor. All the contactors on the controller are equipped with a dashpot for adjusting their time of closing, with the exception of contactors 5*R*, *RU* and *RD*.

To slow down the speed of the car preparatory to stopping, the operator moves the car switch from contact 4 back to contact 2. This interrupts the circuit to relays 5*R* and 10 and to contactors 5 and 9, which causes these to open. When No. 5 opens, it puts the low-speed winding back into circuit and interrupts the circuit to the closing coils of contactors 7 and 8. This causes these contactors to open and connects all the resistance between $T_1$ and $R_4$ and between $T_2$ and $R_8$ in series with the two windings of the motor. Opening of relay 5*R* closes its bottom contact and completes a circuit for the coil on contactor No. 4, which causes this contactor to close and short-circuits the high-speed winding.

The motor is now operating on the low-speed winding at a speed higher than that corresponding to this winding, consequently the motor is converted into an induction generator and supplies a current to the power system. This action causes the motor to produce a retarding action to slow down the machine. The buffer resistance is connected in series with the starting resistance to prevent the slowing-down action of the motor being too abrupt. When No. 10 relay closes its bottom contact, it completes a circuit for the coil on contactor No. 6, which closes and short-circuits the buffer resistance after the motor has partly slowed down. Cutting out the buffer resistance helps to maintain the retarding action of the motor at a value that will slow the car down in a minimum of time, without any disagreeable effects to the passengers. The time of closing of No. 6 contactors is controlled by the opening time of relay 10, which is regulated by a dashpot.

A circuit was made for the coil on No. 7 contactor, when Nos. 4 and 6 closed, which causes No. 7 to close and short-circuit the resistance between $T_1$ and $R_2$ and between $T_2$ and $R_6$. This operation tends further to maintain the retarding action of the motor. When contactor No. 7 closed its center contact, it completed a circuit for the closing coil of No. 8 contactor, which closes and cuts out the remainder of the starting resistance and the motor slows down to a speed corresponding to that of the slow-speed winding.

### Final Stopping of the Car

The final stopping of the car is completed by the operator bringing the car switch to the off position, when all contactors come to their off position, cutting the power out of the motor entirely and releasing the mechanical brake, which is applied by springs.

At the top floor the car is stopped automatically by the limit switches in the hoistway, first by 4-32 opening and switching in the slow-speed winding and short-circuiting the high-speed winding. The final stop is made by limit 8-11 opening, which performs the same function as moving the car switch from No. 2 to the off position.

In the down direction the sequence of events is the same except that the car switch is moved to points 3 and 5 and the down-direction contactor and *RD* relay close instead of the up-direction contactor and relay *RU*.

When tracing out the various circuits Fig. 2, the simplified diagram Fig. 3 will be of assistance in following out these circuits and seeing just what takes place when the various contactors function.

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The Terms Capacity, Efficiency and Economy are often confused, the confusion arising in the fact that they are likely to be used independently of one another and without examining their effect on other efficiencies. For example, it is sometimes advantageous to use a low-priced coal that gives 65 per cent furnace and boiler efficiency as against a higher-priced coal that gives 75 per cent efficiency. The efficiency of the dollar is the real criterion. An increase in capacity at a sacrifice of efficiency may make for economy by saving fixed charges on additional boilers and equipment.

# Special Uses of Welding in Westport Station

**WELDING used for a variety of purposes, including pipe-line fabrication, replacement of studs in boiler handhole plates, repair of broken stoker cranks and removal of generator rotor end rings.**

MUCH of the pioneer work in the application of fusion welding to power plants has been done in the plants of the Consolidated Gas, Electric Light & Power Co., Baltimore. This company has for years made extensive use of both oxyacetylene and electric-arc welding, each process being used for the jobs for which it is best suited.

An article in the June 9, 1925, issue of *Power*, on pipe welding at the Westport Station of this company dealt chiefly with the high-pressure steam lines, most of which are welded by the oxyacetylene process. A pictorial article in the Oct. 26, 1926, issue showed some of the many applications of welding to new-plant construction as exemplified by the Gould Street Station.

The present article, which is designed chiefly to show some special and ingenious applications of welding in the Westport Station, is based on a trip through the plant and information supplied by A. L. Penniman, Jr., superintendent of steam stations for the Consolidated Gas, Electric Light & Power Co. Before describing these special "kinks," a brief review of the history of welding in this plant may be of interest.

### Have Used Welding Since 1912

The Westport Station went into operation in 1906. In 1912 four new boilers were added, all the additional piping required being fabricated by oxyacetylene welding. Beginning in 1913, the replacement of all the older steam piping in the plant was undertaken, because trouble was being had with cast-iron fittings and flanges. All the flanges were removed with the cutting torch. Steel flanges forged with short necks were then welded to the cut pipe ends, adjacent to valves and fittings, while line joints were made by welding in short lengths of pipe. New piping was purchased with Van Stone joints. Lines up to and including 16 in. were revamped in this manner.

Additional boilers and turbines were installed in 1914. Pipe bends were bought from the manufacturer, all other fabrication on these welded lines being done at the power plant. Between 1915 and 1919 thirty more boilers and five more turbines were installed. All the piping, of every description and pressure, was welded. Fewer flanges were used with each successive job.

In 1915 it was necessary to cut a 16-in. outlet from an 18-in. main. With fittings this would have meant an extensive shutdown. The job was accomplished with the torch in 3 hours in the early morning when the system load was light enough to be carried by the water power plant.

The first application of electric welding in the Westport Station was in 1916, when it was used to repair the middle section of a 32,000-sq.ft. surface condenser, a casting 16 ft. in diameter. A little later a condenser arrived from the manufacturer with a piece broken out of the end section. A patch was welded in with the electric arc.

About the same time welding was first used for fabricating tanks, such as storage tanks and open heaters. Old cast-iron heaters were removed and replaced by apparatus of welded steel construction. Welding was specified on all new tanks and heaters purchased.

Since 1916 welding has been used to build up boiler drums where the plates were thinned by corrosion.

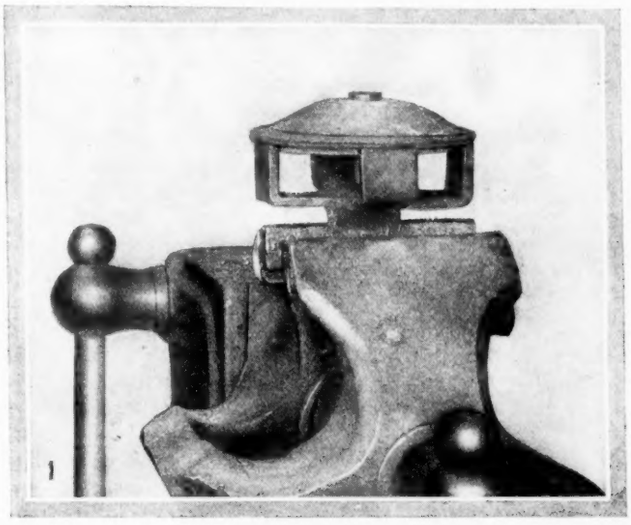


*Fig. 1—Boiler handhole cover set up in special fixture for welding in new stud*

These boilers include not only those in the Westport Station, but also marine boilers in tugboats belonging to the company, as well as boilers in heating plants. No trouble has ever been experienced from these jobs.

Since 1920 fusion welding has been used at Westport to fabricate air ducts, flues, breechings, etc. In 1925 an addition to the station was put in service, using the regenerative cycle with three-stage bleeder heating. For this job six bleeder heaters and two heat exchanges were constructed. These were all of special design. Both gas and electric welding were used extensively in fabricating the heaters and connected piping.

While the gas-welded piping system is perhaps the most important application of welding in the Westport Station, nothing more need be said about this here as it has already been covered by the article in the June 9, 1925 issue of *Power*.

Coming to the special applications illustrated by the accompanying photographs, Fig. 1 shows a boiler handhole cover set up for welding in a new stud. When

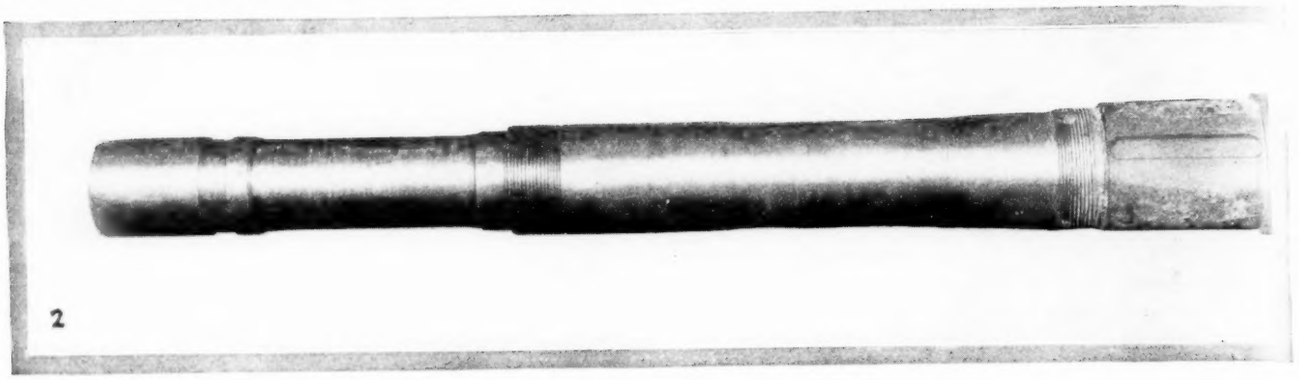


*Fig. 2—Worn shafts like this are built up with the electric arc*



*Figs. 3 and 4—Method of repairing broken stoker-crank*

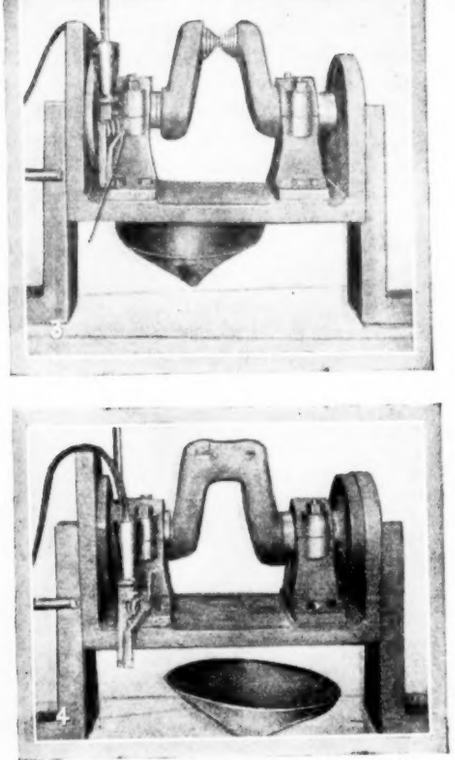
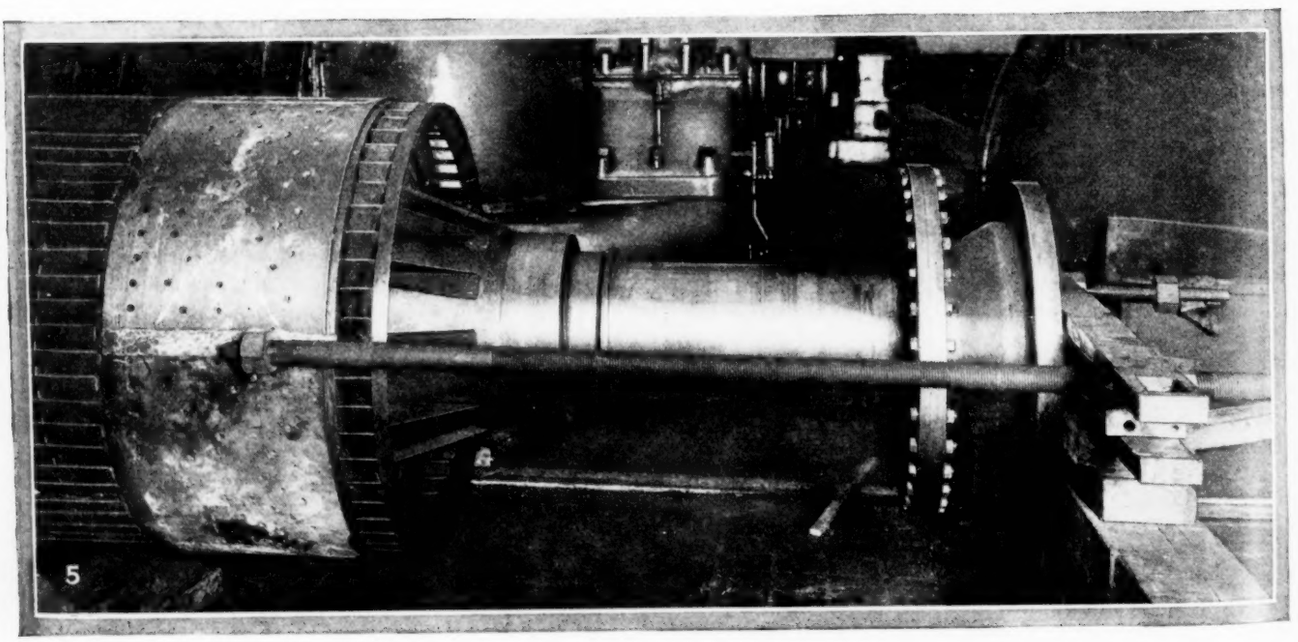




*Fig. 5—Set-up for removing ring of generator rotor*

*Fig. 6—Eroded pump impeller before building up by welding*



the original stud breaks, as is frequently the case, the stub is drilled out and the hole is countersunk slightly on the convex side to facilitate welding. Then the cover is set in the vise jig as shown. This is designed to hold, in proper relation to the cover, a stud threaded on one end only. The two are then welded together at the countersunk end of the hole.

It is necessary to repair several thousand of these covers each year. The cost, using the method just described, is about twenty cents each, whereas new covers cost about $1.50.

Another money-saving repair is illustrated in Figs. 3 and 4. The crankshafts of underfeed stokers are frequently broken or twisted. When this occurs, each half of the crank is put in a jig, and most of the metal of the pin is turned away, leaving two conical stubs. To assure correct alignment before welding, the two halves of the crank are set up in a special fixture, as shown in Fig. 3. Fig. 4 shows the job after the pin has been built up with the electric arc. After the welding is finished, the crankpin is turned down to size. The total cost of this repair is less than five dollars, which is but a fraction of the cost of a new crank throw. Gas welding is used for repairing such cast-iron parts as stoker-shaft brackets and ram brackets.

Fig. 2 shows a worn shaft and Fig. 6 an eroded pump impeller. Both were later built up by electric welding and then machined down to correct shape.

Welding is used in this plant for repairing all parts of material-moving equipment that are subject to breakage or excessive wear.

Worn or corroded plates of coal bunkers are built from time to time, as are also the journals of motors and fans exposed to excessive wear from coal-dust ash, etc.

### Welding Used on a Ring Pulling Job

Fig. 5 is an interesting example of the many special jobs in which welding has played a part. It was necessary to remove the end rings of the field of one of the large generating units. Two strips of steel $\frac{3}{4}$x3 in. in section were electrically welded on opposite sides of the ring and parallel to its axis. To each of these strips a $2\frac{1}{2}$-in. nut was welded, as shown. With the aid of two long threaded $2\frac{1}{2}$-in. rods and an I-beam "strong-back," it was possible to pull the ring off. Before the pulling operation was begun, the holes in the ring were filled with magnesia to protect the windings during the preliminary heating of the ring.

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Collapse of the 90-Ft. Stack on the power house of the Birmingham Electric Co. at Birmingham, Ala., on Jan. 14, which resulted in the death of two men, is believed to have been due to the rusting of the heads of rivets concealed between the outside shell of the stack and the lining. The stack had been in place about 25 years. It was of $\frac{1}{4}$-in. plate and lined to within 30 ft. of the top. The point of failure was 48 ft. below the top, and at the time of the accident the work of relining the stack had been undertaken and the old lining had been removed to a point about 6 ft. below the point of failure. Examination of the stack showed no rupture of plate, but pitting to the depth of half the thickness of the plate on the inside and heads of rivets badly corroded. Failure occurred through shearing of the rivets in the region where the corrosion occurred. — *Engineering News-Record.*

# Locating the Cause of Pump Troubles

By J. Elmer Housley

Applying fundamentals in power-plant maintenance is of equal importance to their use in the design of the equipment. In maintenance it is concerned with the primary or fundamental cause of certain results, and results are as strange sometimes as ailments of the human body which have their seat in one part of the body while the pain is exhibited in some other part.

### Causes of Pump Trouble

One of the fundamental causes of centrifugal pump trouble is a shaft running out of true, bent from any number of possible causes and never suspected of being the cause of motor overloads, worn flexible couplings, excessive wearing of packing, loose bearing shells in the housing, too rapid wearing of bearings, loss of thrust bearings, governor trouble on steam-turbine drives and damaged seal or clearance rings and impellers in the pump.

The question arises as to how to determine the primary cause of any of the actions mentioned—that is, if they are not local troubles. First, a careful study of the particular repair job will indicate whether the trouble could be caused by a local defect. Second, if no local defect is apparent, the entire machine should be torn down and every part examined for evidence of other trouble which would give confirmation of the primary cause. The pump rotor should be put in a lathe and checked by a shaft indicator over its entire length as far as possible, and then the rotor should be carefully balanced. This procedure becomes increasingly important if the speed of the unit happens to be above 600 r.p.m. or if the impeller is of large diameter. It is seldom that a good mechanic will fail to find the real cause and eliminate the trouble with the unit if this procedure is followed. Dismantling takes time and is expensive, but so are constant recurrences of the same trouble which may result in total destruction of the unit in time.

### Pump on Jet Condenser

One case in mind exhibits the progressive nature of such a shaft trouble. The unit was the discharge pump of a low-level jet condenser. The pump was a 16-in. screw impeller type operating nominally at 1,800 r.p.m. and direct connected to a 200-hp., 2,200-volt three-phase 60-cycle squirrel-cage induction motor, requiring 48 amperes at full load. The first symptom of trouble was the loss of an outside bearing on the motor, and the whole motor was reported unusually warm just before the bearing wiped. The bearing was replaced, and as the weather was warm and the location of the unit adjacent to the warm air discharge from the generator, an air hose was kept playing on the bearing housing. The motor as a whole in a few hours heated up to a temperature of about 140 deg. F. A split-type current transformer with its calibrated leads and ammeter was secured and the transformer put around one motor lead at the compensator. The meter indicated 60 amperes, or about a 25 per cent overload on the motor.

The valve on the water-inlet line to the condenser was

closed a few turns until the motor current dropped to 45 to 48 amperes in order to protect the motor. The water level in the condenser went below the gage glass, and the vacuum for the turbine declined about 1½ in. of mercury owing to the decrease in the amount of cooling water, which came from a spray pond. It was necessary to keep the unit in service to supply the power demand. A few days later the outside bearing on the pump was found to be vibrating slightly in the housing, which was the first noticeable vibration to appear.

The following Sunday a short shutdown was made, and a light shim was placed around the bearing bushing and the cap replaced. The pump packing was found to be about gone, although it had been renewed about three weeks previously, and the pump was repacked. In the meantime the rated discharge of the pump was looked up and found to be 6,000 gal. per min. The unit was equipped with a flow meter and thermometer on the intake and discharge side and a vacuum gage.

### Diagnosing the Trouble

A calculation showed we were pumping only 4,000 gal. per min. with the motor fully loaded, besides an old centrifugal vacuum pump had been removed from the pump shaft and a radojet air pump had been substituted, which lowered the rated load. Some trouble was evident, but the cause was not externally apparent. Arrangements were made to shift the load of this unit to another plant and the pump was dismantled. The impeller blades gave evidence of having been lightly rubbing the pump cylinder. The clearance at this point was nominally just under $\frac{1}{16}$ in. The pump rotor was put in a lathe and was found to be out of true about 0.025 in. near the middle of the shaft. To correct this condition, a light cut was made over the entire shaft to true it up. A heavier cut was made under the screw-type blades, and a bushing was pressed on the shaft and keyed and the impeller keyed to the bushing. This required the rebabbitting of the bearings; they were worn excessively, and a change in the size of shaft packing used. The rotor was balanced carefully after the completion of the job. The pump was put back in service and has operated for over a year and a half without any further repairs except for normal replacement of shaft packing.

### Turbine-Driven Unit Gave Trouble

Probably not often two similar cases will occur in the same plant within one year. However, they did in the plant under discussion, possibly to prove the rule. To make truth still stranger, the shafts in both the pump and the turbine were found out of true. The unit was a boiler-feed pump rated at 500 gal. per min., at 2,600 r.p.m. under a 650-ft. head. This unit supplied boiler-feed water to four 9,940-sq.ft. 210-lb. boilers. Normally, three boilers were operated at a rating of about 160 per cent. The other feed pump was somewhat smaller and did not satisfactorily handle three boilers, which made continuity of service of the big pump important in the operation of the plant. It was the old familiar story—something was always happening to this unit. The thrust bearing would wear rapidly and always run hot, the bearing on the coupling side would show signs of fractured babbitt and excessive wear in one month. The pump packing could not be kept tight enough to prevent leakage without burning the packing.

On the steam-turbine end the governor was mounted on the end of the shaft. A number of small parts on the governor mechanism broke and the knife-edges were badly rounded. The turbine thrust bearing was on the outside or steam inlet end, and shaft collars run against the ends of a bronze bearing bushing. This bronze bearing would be replaced about once per month because of shaft vibration and bad lubrication as was found later. However, until the fundamental trouble was corrected, the lubrication problem of oiling a bearing operating around 200 deg. F., could not be solved. The unit ran very rough and the foregoing troubles, which usually showed up one after another at intervals, were blamed on the high speed and a "run of hard luck" by the operators.

We were not sold on these ideas, however, and at the first opportunity both the pump and the turbine were completely dismantled. The pump was scaled up rather badly, and the clearance rings showed signs of rubbing and the clearance was greater than permissible. The pump rotor was tested in a lathe and found to be out of true about 0.01 in. and out of balance. A new rotor complete with clearance rings was on hand, so after cleaning the cylinder and diaphragms with dilute muriatic acid and washing thoroughly with a hose after half an hour's soaking, the pump was ready for reassembly. In the meantime the bearings were poured and turned.

### Testing Turbine Shaft

The turbine shaft was tested for trueness with a shaft indicator in a lathe and was found "off" about 0.008 in. No spare runner was in stock, so an attempt was made to straighten the shaft. It could not be made to come true closer than 0.002 in. A new bronze bearing was made in the shop, and the other bearing was poured and turned. A light cut was necessary on each bearing surface of the shaft. After careful static balancing, the turbine was reassembled. The entire unit ran much steadier, but a small amount of vibration was still apparent in the turbine. It was thought best to order a new turbine runner and wearing parts of the governor. This was done, and after they were installed, no further trouble was experienced except lubrication trouble on the bronze bearing of the turbine, which was solved by the use of a heavy gas-engine oil for this bearing. The unit has operated now for nearly two years without forced recourse to the small pump. There is no vibration anywhere near or on the unit which can be detected. Except for packing, the repair expense has been nothing with the unit in operation 70 per cent of the time during the last two years, the plant being in stand-by service.

A brief is held for the plan of completely dismantling centrifugal pumps when a series of troubles ensue which cannot be eliminated or definitely assigned to local defects. Otherwise perfectly good equipment may be condemned as poorly designed or built, when as a matter of fact the trouble may have originated by the stresses set up by the loss of a bearing or improper handling of rotors during assembly or by foreign material getting into the pump.

For a Direct-Acting Steam Pump it is dangerous to allow the piston to travel as near the cylinder heads as in the ordinary engine, since a slight change in the conditions of steam pressure, pump friction or the pressure pumped against, might cause the piston to strike.

# High Heat-Transfer Rates for Surface Type Desuperheaters

By P. H. HARDIE*

*PRACTICALLY no information is available on the subject of heat transfer from flowing superheated steam to water that is not moving, and what little information has been published deals only with low velocities. Results obtained from tests conducted at the Hudson Avenue Station of the Brooklyn Edison Company indicate that the transfer rate is extremely high for high velocities. Some of the factors affecting the transfer rate are discussed in this article.*

THE rapid trend toward high pressures and temperatures for increased economy in steam-power plants has led a number of companies to install units in existing stations to operate at a pressure and temperature above those at which older units are operating. If a tie line is provided between the high- and

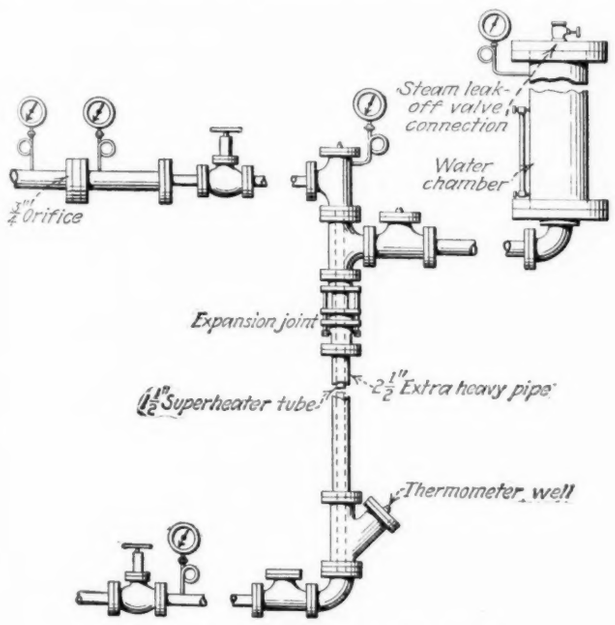


*Fig. 1—Layout of test equipment*

the low-pressure boilers, which is generally desirable and sometimes essential, it is necessary to install a reducing valve in the tie line, and also some type of desuperheater if the older equipment cannot be operated safely with steam at the higher temperature. Surface-type desuperheaters are an absolute assurance against having slugs of water carried over and for that reason are highly desirable, but owing to the common impression that the heat-transfer rate would be low and would require a desuperheater of prohibitive size, they have not been used for this purpose up to the present time. An article in *Power* for Nov. 30, 1926, page 803, describes a large unit designed and installed in the Hudson Avenue Station of the Brooklyn Edison Company.

The tests reported in this article were conducted to furnish data for the design of this desuperheater, with the apparatus shown in Fig. 1, which was made to duplicate as nearly as possible the conditions existing in the actual desuperheater. The main test section consisted of a 14-ft. length of 1½-in. boiler tube located concentrically inside a 2½-in. extra-heavy steel pipe. Fourteen feet is approximately the vertical height of the actual desuperheater tubes when completely submerged. All tests were made with full submergence, as shown by the gage glasses on the water chamber.

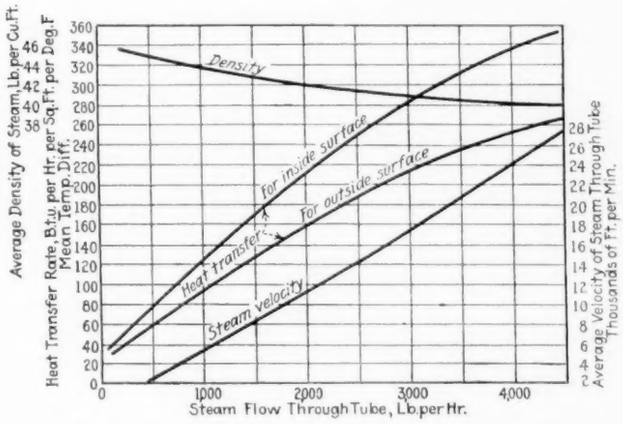
Average Density of Steam, Lb. per Cu. Ft.
Heat Transfer Rate, B.t.u. per Hr. per Sq. Ft. per Deg. F Mean Temp. Diff.
Average Velocity of Steam Through Tube, Thousands of Ft. per Min.
Density
For inside surface
For outside surface
Heat transfer
Steam velocity
Steam Flow Through Tube, Lb. per Hr.

*Fig. 2—Test results plotted against steam flow*

### Test Conditions

Steam at 275 lb. gage pressure and 600 deg. total temperature was supplied from an auxiliary steam line. The piping was installed so that tests could be made with the steam flowing either upward or downward through the test section. As shown in Fig. 1, the direction of steam flow would be upward. Most of the runs were made with the steam flowing upward, as the test conditions were easier to control for upward flow than downward flow. However, the best runs with downward flow gave the same heat transfer rate as for upward flow under like conditions.

The quantity of steam flowing through the apparatus was regulated by the valve before the orifice in the exhaust line and measured by the orifice. From the orifice the exhaust steam was piped to a small condenser where it was condensed and weighed for the first set of runs and found to check with the weights as calculated from the orifice readings. For all other runs the orifice readings only were necessary.

The heat transferred was determined by measuring the heat given up by the superheated steam in passing

*Assistant engineer, Research Bureau, Brooklyn Edison Co., Inc.

through the test section. No attempt was made to determine the heat-transfer rate by measuring the heat absorbed by the water in the jacket, owing to the complications involved in making such measurements, which, when obtained, would not give as accurate results as those determined from the steam side.

Before any test was started, the conditions were

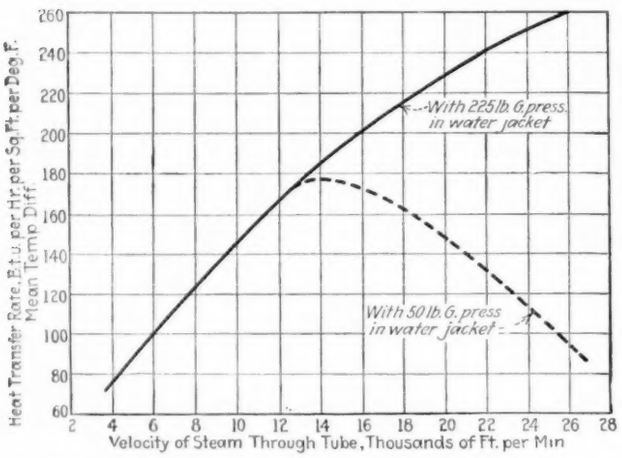
Heat Transfer Rate, B.t.u. per Hr. per Sq. Ft. per Deg. F. Mean Temp. Diff.
260
240
220
200
180
160
140
120
100
80
60
With 225 lb. G. press. in water jacket
With 50 lb. G. press in water jacket
2 4 6 8 10 12 14 16 18 20 22 24 26 28
Velocity of Steam Through Tube, Thousands of Ft. per Min

*Fig. 3—Effect of steam velocity and pressure on heat-transfer rate*

allowed to become constant. Readings were taken every five minutes, and the length of the tests varied from 30 to 40 minutes.

## Unexpected Results

A number of surprising and peculiar results were obtained from these tests. First of all, the heat-transfer rates were found to be much higher than was expected. In the accompanying table are given the final results of the test, and Fig. 2 shows them in graphical form. The heat-transfer rates are given for both the inside and the outside surfaces of the tube. However, it is the general practice to base the transfer rate on the surface with which the gas comes in contact, in this case the inside surface of the tube.

The first set of tests were made with only high velocities through the tube, and they gave results that were very puzzling, as they showed decreasing heat-transfer rates with increasing velocity above 14,000 ft. per min., as shown by the dotted curve in Fig. 3. These tests were made with a pressure of 50 lb. gage in the water jacket, as this pressure gave a mean temperature difference equal to that expected in the actual desuperheater.

Tests were then made to determine the cause of the decreasing heat-transfer rate, and it was found that at maximum flow a marked change in the heat transfer rate was obtained by changing the pressure in the water jacket, which changed the temperature of the water and in turn the mean temperature difference. Fig. 4 shows the heat-transfer rate plotted against mean temperature difference, and Fig. 5 shows the total heat transferred plotted against mean temperature difference for the same tests, indicating that the total heat transferred actually increased as the thermal head decreased.

## Reasons for Results

The reason for this phenomenon is hard to determine definitely from any of the results of the tests, but it is evidently caused on the water side and not the steam side of the apparatus. The most plausible explanation is that it is due to the volume of evaporated steam that must pass upward through the water in the jacket. At atmospheric pressure a pound of steam has a volume of 26.8 cu.ft. and at 225 lb. gage only 1.92 cu.ft., so that at atmospheric pressure approximately twelve times as much steam as for 225 lb. had to pass upward through the water jacket for the same amount of total heat transferred.[1] Since the change in the mean temperature

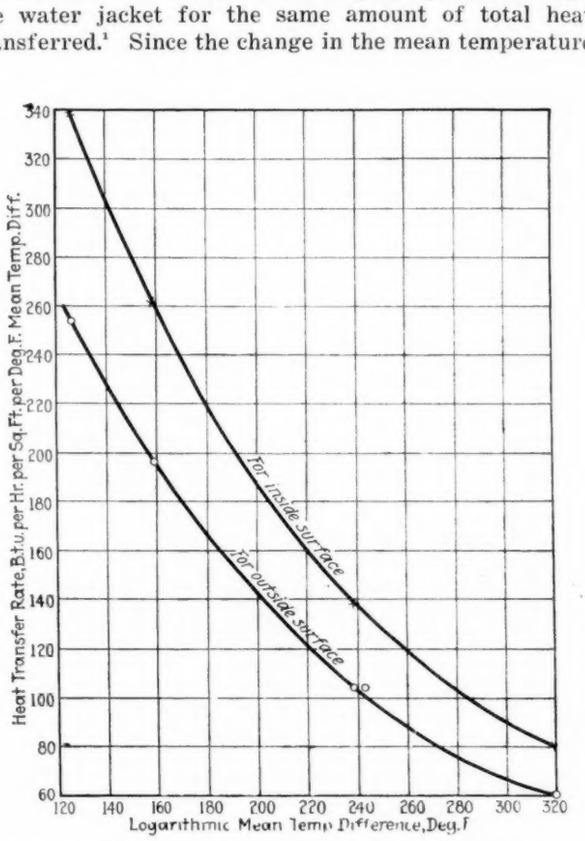


*Fig. 4—Variation of heat-transfer rate with mean temperature difference*

difference was accompanied by changing the pressure between these limits, it is reasonable to assume that the volume of steam bubbles passing up through the water

[1]The ratio of the specific volumes is 14, but the heat of vaporization at atmospheric pressure is 970 and at 225 lb. gage pressure it is 830, which reduces the volume of the steam evaporated for the same heat transferred by the ratio $\frac{830}{970}$, making the ratio of the volume of steam evaporated 12 instead of 14.

DESUPERHEATER HEAT-TRANSFER TESTS

Test Data and Results

| Steam Flow, Lb. per Hr. | Steam Press., Lb. per Sq.In. Abs. Inlet | Steam Press., Lb. per Sq.In. Abs. Outlet | Steam Temperature, Deg. F. Inlet | Steam Temperature, Deg. F. Outlet | Average Water Temperature, Deg. F. | Water Jacket Pressure Lb. per Sq.In. Abs. | Average Density of Steam, Lb. per Cu.Ft. | Average Specific Heat of Steam | Logarithmic Mean Temperature Difference, Deg. F. | Average Steam Velocity Through Tube Ft. per Sec. | Average Steam Velocity Through Tube Ft. per Min. | Heat Transfer Rate B.t.u. per Sq.Ft. per Hr. Deg. M.T.D.[1] Outside Surface | Heat Transfer Rate B.t.u. per Sq.Ft. per Hr. Deg. M.T.D.[1] Inside Surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4,065 | 238 | 216 | 572 | 483 | 398 | 240 | 0.400 | 0.491 | 126 | 409 | 24,500 | 254 | 339 |
| 3,000 | 241 | 229 | 573 | 478 | 395 | 240 | 0.417 | 0.510 | 125 | 290 | 17,400 | 212 | 283 |
| 1,913 | 239 | 234 | 563 | 467 | 397 | 240 | 0.426 | 0.518 | 111 | 181 | 10,840 | 155 | 207 |
| 1,218 | 239 | 237 | 553 | 459 | 397 | 240 | 0.435 | 0.521 | 102 | 113 | 6,750 | 106 | 141 |
| 809 | 239 | 237 | 547 | 445 | 392 | 239 | 0.441 | 0.537 | 95 | 74 | 4,440 | 84 | 112 |

in the jacket is the real cause of the changing heat-transfer rate at constant steam flow. When the volume becomes too great, the bubbles in rising probably tend to sweep the water away from the tube and prevent good contact, thereby decreasing the ability of the tube to transmit heat. The ratio of free water-jacket cross-sectional area to tube surface is therefore important.

The solid curve in Fig. 3 and all curves in Fig. 2 are plotted from tests with the pressure in the water jacket 225 lb. gage. From Fig. 4 it seems that it would be possible to obtain an even higher heat-transfer rate at the maximum flow if the pressure in the water jacket were increased above 225 lb. gage. This pressure was the maximum safe working pressure for the test apparatus, and therefore it was impossible to check this point. For low steam velocities changing the water-jacket pressure had practically no effect on the heat-transfer rate.

### Effect of Specific Heat

A questionable factor in determining the heat-transfer rate from the drop in temperature and pressure of the steam in passing through the test section is the average specific heat of the steam between the two limits. The heat-transfer rates given in this report were figured from the difference in total heats, using

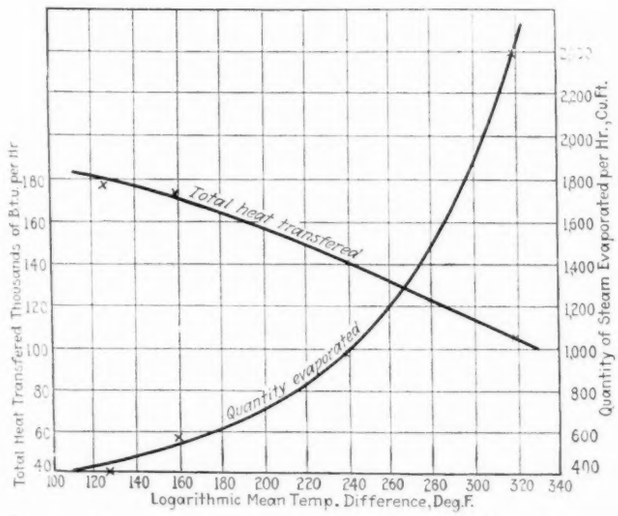


*Fig. 5—Variation of total heat transferred with mean temperature difference*

Ellenwood's Steam Charts, which are based on Marks and Davis' Steam Tables. The average specific heats given in the table are also figured from the difference in total heats and are given merely as a matter of reference. The steam densities given in the same table are an average of the densities at inlet and outlet of the test tube.

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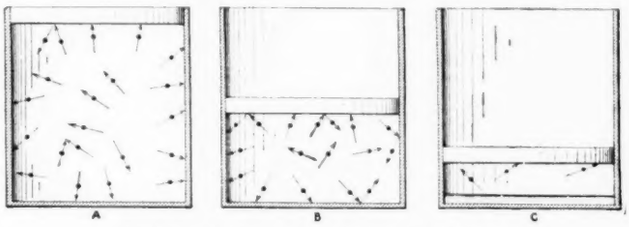
Practically All the Power Consumed in a textile mill is transferred into heat and only a very small part used in elevating material or stored in the elastic twist of the yarn. This heat performs no useful purpose except, incidentally, to assist in the heating of the mill in cold weather. On the other hand, it increases the sensible warmth in the building in warm weather and makes necessary the supplying of additional artificial humidity so as to provide proper operating conditions.—George Wrigley, in *Mechanical Engineering*.

## Why a Compressor Is Needed in the Refrigerating Plant

By G. Grow

By many refrigerating engineers the fundamental principles that are the groundwork of the plant's operation are not fully understood. All appreciate the necessity of drawing the ammonia vapor from the evaporating coils and compressing it to a higher pressure, but




*Action of gas molecules in a cylinder*

why the compressor is needed may be a little difficult to explain. Ask yourself the question, Why will the ammonia vapor condense into a liquor if raised to 150 lb. gage pressure and then cooled to 80 deg. F. temperature? The popular answer will be that by removing heat from it the gas will be condensed. If this were all the truth, why not cool it at the suction pressure?

The need for a high pressure when condensing ammonia at the usual cooling-water temperatures may be blamed upon the molecules making up the gas. These molecules by their velocity create the pressure and temperature conditions indicated by the pressure gage and thermometer. If, as at *A*, in the figure, we have a chamber filled with ammonia vapor, the rapidly moving molecules move back and forth, striking others as well as the container walls. Their velocity determines the pressure, which will be assumed to be 30 lb. absolute, and the temperature, which will be 0 deg. F.

If, now, the compartment be made smaller, by pushing in the movable cover as at *B*, the molecules will not have so far to go to strike the walls and so more of them will strike the walls per second, causing the pressure and temperature to rise. If, now, the cover be moved in sufficiently, the number of molecules per cubic inch will become so great and the spaces between so limited that the temperature and pressure will reach high values. Now suppose by a process of cooling, part of the kinetic energy of the molecules be removed. The velocity of each molecule will then be reduced to a point that it does not overcome the attraction of the other molecules. The mass of particles then may be pictured as moving in curvilinear paths about one another, and the resulting density of the mass is such that we say it is liquid as at *C*. Part of the molecules, however, have such a high velocity that the cooling does not reduce it sufficiently to hold the molecules within the range of attraction of the others. This portion remains a vapor, and if the cooling were continued at lower temperatures, more and more of these would change to the liquid state, but always some will be speedy enough to escape the attraction of the others.

The compressor piston takes the place of the movable cover, and it can be stated that the sole purpose of the compressor is so to increase the number of molecules per unit volume that when a part of their velocity is removed, they will fall under the mutual attraction of

each other, which will give them the characteristic we call liquid. The squeezing of the gas into a smaller volume requires work to be done by the compressor. As the piston moves inwardly, the bombardment of the molecules on the piston face requires the exertion of a force to counteract the effect. Furthermore, when the molecules rebound from the piston, they possess more kinetic energy than before, by reason of the energy they have absorbed from the moving piston. For this reason, after compression the ammonia gas possesses more energy than before compression, the difference being the energy absorbed from the moving piston, which is obtained from the engine or motor driving the compressor.

## An Unusual Automatic Hydro-Electric Station

Several unusual features have been incorporated in the Parishville automatic hydro-electric station of the St. Lawrence Valley Power Corporation at Potsdam, N. Y., including absence of a surge tank or relief valve of any kind in the steel pipe line connecting the dam to the station. The generating unit is a single General Electric 3,000-kva. 514-r.p.m. 2,300-volt three-phase 60-cycle generator with direct-connected exciter driven by a horizontal reaction-type turbine. The station is entirely controlled by automatic switching equipment, with all the usual protective features for shutting down the machine in case of trouble. The turbine operates under an effective head of 130 ft., supplied through a pipe line running to a dam about half a mile away.

Omission of the surge tank or relief valve is possible since the ordinary oil-pressure type governor for speed control and regulation is not used. Instead, the gate mechanism is controlled by a simple hydraulically operated servo-motor, under the control of a small alternating-current solenoid. A relatively slow motion is employed in operating the gates, to prevent causing surge pressures and avoid straining the pipe lines.

In order to prevent excessive overspeed, a special grid resistance is connected across the generator terminals just previous to the opening of the main oil circuit breaker in case of an abnormal shutdown because of a short-circuit on the line or the sudden loss of load for any other reason. This artificial load is designed to hold the generator to practically normal speed until the gates have closed sufficiently to prevent its running at overspeed without external load. During normal shutdown the generator is not disconnected from the line until the gates are practically closed, and the artificial load therefore does not come into use.

Since the gate control mechanism has no dashpot equipment to prevent excessive acceleration before the machine is connected to the line, a special limit switch is used. This allows the gates to open immediately to the breakaway point of the wheel, at which point the limit switch trips the control solenoid, which action causes the gates to close slowly to about 5 per cent opening, where the limit switch again trips and allows the gates to open. This operation is continued until the oil circuit breaker has been closed and the machine connected to the line, after which the gates are opened to the full or a predetermined position.

Since the gate-control mechanism is operated by penstock pressure, a relay is provided to shut down the unit on loss of this pressure while there is still enough pressure to close the gates.


# An Opportunity to win $500

*Enter the "Power Prize Contest." You may win the money; you are sure to acquire greater prestige; and others will benefit by learning how you effected plant improvement.*

FOR the benefit of new readers and those who may have missed the announcements, in the last two issues, of the "Power Prize Contest" the conditions are here reiterated.

**1st Prize $500**
**2nd Prize 250**
**3rd Prize 100**

FOR the articles showing the most commendable improvements in the results obtained from the modernization, reorganization or improved operation of a power plant, during the last two years.

1 The manuscripts submitted will be judged on (a) the value of the results, not alone on savings in dollars, (b) ingenuity displayed, (c) general interest and applicability to other plants, (d) method of presentation.

2 The identity of the plant must be revealed in the text and the story must be subject to verification.

3 Articles should be as short as consistent with telling the facts; preferably not exceeding 4,000 words exclusive of illustrations, which are desirable.

4 All manuscripts should be submitted by May 15, addressed to *Power*, Tenth Ave. at 36th St., New York, and plainly marked "Entered in Power Prize Contest." The manuscripts should not be signed but each should be accompanied by a letter of transmittal giving author's name and address. For the purpose of judging, such letters will be keyed to the manuscript and filed.

5 Articles which do not win prizes, but which possess sufficient merit to warrant publication, will be used subsequently and paid for at regular rates.

6 The competition is open to all without regard to position.

7 Names of the judges selected by the editors will be announced later.

## Society Meetings

ARE there too many engineering society meetings? Are they more numerous than is commensurate with advancement in the field? Do they exact too much time of the busy engineer? And are the papers and talks always selected with a view to supplying the most helpful information? These are moot questions.

It is quite evident that things are moving fast in engineering lines, and it is important that the societies keep pace with these developments. To do otherwise, would represent failure to serve the members properly. Moreover, this is not only an age of co-operative endeavor, but also of co-operation in thinking.

While the tendency in education is away from specialization, the reverse holds true in the fields of production and application. This has been responsible for the formation of many specialized societies, both local and national; and to prevent further extension of this idea, many of the older and broader societies have established technical divisions to cover these specialized activities. Sometimes these overlap.

The difficulty is that each group, fearful lest it lose some of the lime-light, demands and usually gets its full share of the program, whether or not it happens to have a real message to get across at the time.

Furthermore, to get the most out of a meeting, one often desires to supplement it with further study, but demands upon time interpose; another meeting is already at hand, and the result is a mass of very superficial ideas.

Quality rather than quantity should guide more "meetings and program" committees.

## The Growth of Plant Capacity

IN DESCRIBING new large power stations it has for some time been the custom to lay stress on the installed rather than the so-called ultimate capacity. From the first, ultimate capacity has been looked upon with some degree of suspicion. And it still is, but for a reason that is the very opposite of that formerly held. A few years ago, when somebody put in a plant of 100,000 kilowatts initial capacity and said that the ultimate would be 300,000 kilowatts, there was a tendency for the members of the engineering fraternity to discount the prediction.

Now the tables have been turned. Several stations started within the last five years have already reached a point where the original claims for ultimate capacity are seen to be ultra-conservative rather than exaggerated. For example, when the first 100,000-kilowatt section of the Hudson Avenue Station of the Brooklyn Edison Company went into operation in 1924, the announced ultimate capacity of 400,000 kilowatts seemed a bit visionary to some. With the addition of the latest unit (80,000 kilowatts) the station capacity has already passed 300,000 kilowatts, and it is evident that far more than the 400,000 kilowatts, originally contemplated, can be squeezed into the definitely restricted plot of land. In fact, the possibility of accommodating 700,000 kilowatts is already obvious. Even this figure may later be raised.

Similar conditions are found in other plants. When the Hell Gate Station was started in 1921, the ultimate capacity was given as 280,000 kilowatts. The capacity is already 285,000 kilowatts and the installation of the new 160,000-kilowatt turbine now on order will raise the total to 445,000 kilowatts.

What has happened is that system loads are increasing at an unprecedented rate, while at the same time new units tend to be much larger than those first installed. These take but little more floor space than units of considerably smaller capacity.

The chief lesson that can be drawn from all this is that anybody who tries to guess even five years ahead in the power field these days has a difficult task.

## Controllers for Power-Plant Auxiliary Motors

THE FACT that a controller has been making good on a certain size of motor driving a given type of load, is not a guarantee of its satisfactory operation under these load conditions in all cases. When a motor is installed some distance away from the power house, in case of a short-circuit the current inrush into the faults will be much less than if a similar fault were to occur in the power house. Thus a controller contactor will be subjected to less severe service when used on motors supplied from lines outside the power house than when on the same motor inside the plant. The impedance of the lines and transforming equipment is considerable and is an important factor in limiting the value of a short-circuit current.

In most of the applications outside the power house, if the motor gets into trouble, it can immediately be disconnected from the line automatically, without causing any serious inconvenience. In the power house, if possible, the essential auxiliaries are required to stay on the line, in case they get into trouble, until other units can be started to take their place. Such conditions subject controller contactors to much more serious service than when the motor is protected for the usual industrial applications. This severe service of the power house has caused contactors that have given a good account of themselves in industrial applications, to fail after a short life in some of the power-plant auxiliary services.

In the power plant reliability is of greater importance than in many industrial applications, and this becomes increasingly true when greater stress is placed on continuity of service. This applies not only in the central

station, but also in the industrial power plant. A controller failing in a manufacturing process may stop only one machine, but in the power house there is danger of stopping the whole works.

Opening and closing a circuit is not the only requirement of a contactor. The ability to remain closed for long periods without overheating may be of equal importance. On the average industrial-application controller, contactors are generally required to open and close at fairly short intervals and, in doing so, wear the contact surfaces into good electrical contact. On some of the power-house applications a contactor may remain closed for days, in which case the contact surfaces may become oxidized and cause serious heating. This has occurred to such an extent in some installations that it was found advisable to silver-plate the contacts.

Standard equipment should be used wherever it is economical to do so, as this keeps down costs and simplifies maintenance. The use of this apparatus is not always advisable, as the location of the motor on the power system, its protection and other factors must be kept in mind.

## How Should Power Generating Units Be Rated?

EVER since the days of James Watt horsepower has been used as a unit for expressing the output of power producing and transforming machines. With the advent of the electrical generator the kilowatt came into vogue as a unit of rating for this class of equipment. Out of this grew the common practice of rating the engine or waterwheel in horsepower and the generator that the prime mover was driving, in kilowatts. As alternating-current power systems grew, the power factors of the system became a controlling element in the rating of the machine, if the most efficient combination of prime mover and generator was to be obtained. This brought into existence a new unit, the kilovolt-ampere, for rating alternating-current generators.

These ratings have developed an undesirable situation in the industry. Engines of all kinds and waterwheels are in general rated in horsepower. This rating is usually also applied to small and medium-sized steam turbines, while the large units are rated in kilowatts. Where the prime movers drive direct-current generators, the driven machine is rated in kilowatts. When alternating-current generators are used, it is common to see the rating expressed in kilowatts without any mention of power factor, in kilowatts with reference to the power factor, or in kilovolt-amperes with or without mention of the power factor. In these days, when large rating figures are so much in evidence, apparently sometimes the kilowatt or kilovolt-ampere does not give a figure large enough, and to meet the situation the rating is expressed in horsepower. When this is done, under conditions that are unusual, the horsepower may be easily taken to mean kilowatts, and a machine is reported to be about thirty-three per cent larger than it actually is.

Such a conglomerate of ratings is, to say the least, confusion, frequently failing to give the desired information, and is a source of errors. Everyone will agree that speaking a common language is essential to a common understanding, and this is needed in the rating of power-generating equipment. What this rating should be is open to discussion, but whatever the unit or combination of units is, it should leave no question as to the capacity of a machine under a given set of conditions.

On account of the difference in the factors that limit the loading of the prime movers, and the alternating-current generator, the unit of rating must include the power factor. A kilovolt-ampere rating alone has no meaning, since it may be at anything from an equal value in kilowatts at unity power factor to zero kilowatts at zero power factor. Although the generator will operate at unity power factor and carry its full rated load at normal voltage, the prime mover on modern machines will probably not have sufficient capacity to drive the generator at this load. On the other hand, at low lagging power factors, the limitations due to heating of the field coils will prevent the machine from delivering its rated load at normal voltage. If a rating in kilowatts or kilovolt-amperes at a specified power factor is used, it can be made to tell the whole story of both the prime mover's and the generator's rating. This rating is recommended in the American Institute of Electrical Engineers Standards for rating alternating-current generators.

## Proper Mean Effective Pressures in Diesel Engines

THE bone of discussion, if not of contention, in Diesel engine circles is the mean effective pressures. With these pressures, at full load rating, varying from forty to over one hundred pounds, the tyro is at a loss as to the value to be taken as standard. Those who advocate the lowest pressures argue somewhat plausibly that a low mean effective pressure reduces the mechanical stress in the crankshaft and other parts, forgetting for the moment that the maximum stress is not due to the mean but to the peak pressure. Neither does a low mean pressure indicate a low maximum pressure.

On the other hand, the proponents of high mean pressures point out that a smaller engine can be used, which permits either a lower investment or better workmanship. As a further argument the excellent fuel rate at these high pressures is cited as proof that no thermodynamic law is being violated.

Between these two extremes are those who insist on the advantages of using mean pressures of around seventy pounds.

In the arguments the matter of design has been ignored. Surely, pressures possible in a clearly scavenged engine cannot be obtained in a machine where a goodly part of the burnt gases are trapped within the cylinder. Then, too, the type or method of fuel introduction has a marked influence upon what pressures are obtainable. With the same degree of atomization it is possible for a solid-injection engine to show the same indicated mean effective pressure as can an air-injection engine. Since the former dispenses with the air compressor, its mechanical efficiency is better and the brake mean effective pressure shows a higher value. But the elimination of the compressor is not going to permit all engines to show higher mean pressure. Much depends upon the kind of injection system and the design of combustion chamber. Neither does the ability to carry extremely high pressures prove that they are advisable. The character of the load is a factor not to be ignored by the designer when choosing the pressures for a new type.

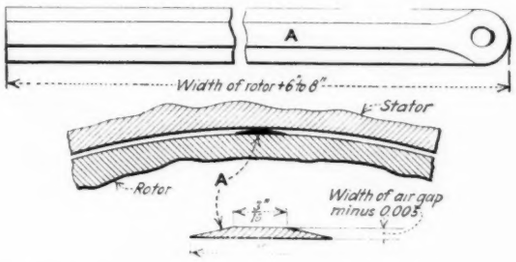
# Ideas From Practical Men

*Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted.*

## Gaging the Air Gap at Regular Intervals Prevents Interruptions

A squirrel-cage induction motor is a comparatively simple machine, but it is surprising how little it takes sometimes to put it out of operation. Recently a small amount of wear in the bearings put an important 25-hp. motor out of operation for four hours and held up the production of 80 men.

The motor was used to drive the forced-draft fan supplying the air to two water-tube boilers. A workman




*Steel strip for gaging air gap on induction motors*

was giving the motor its regular cleaning with compressed air and when ready to put it in service again, he found that it would not start. Removing the belt did not help, but turning the pulley by hand showed where the trouble was. The rotor was down on the armature.

There were no duplicate bearings in stock, and by the time new ones were secured four hours had elapsed. The gases of combustion were used in process work, and when the fan went out of order we had to fall back on the induced-draft fan, consequently the combustion gases were discharged directly to the atmosphere. As the fan was not large enough to give the necessary draft on the boilers, an interruption in the service resulted.

Inspection of the old bearings revealed about $\frac{1}{16}$ in. wear on the one next to the pulley and nearly the same on the other one. While the motor was in operation, the rotation tended to keep it centered, but when stopped and then started again, the magnetic field held it fast at the bottom. Subsequently, the air gap was tested on all motors, and regular inspection will be the order of the day.

JOSEPH O'BRIEN.

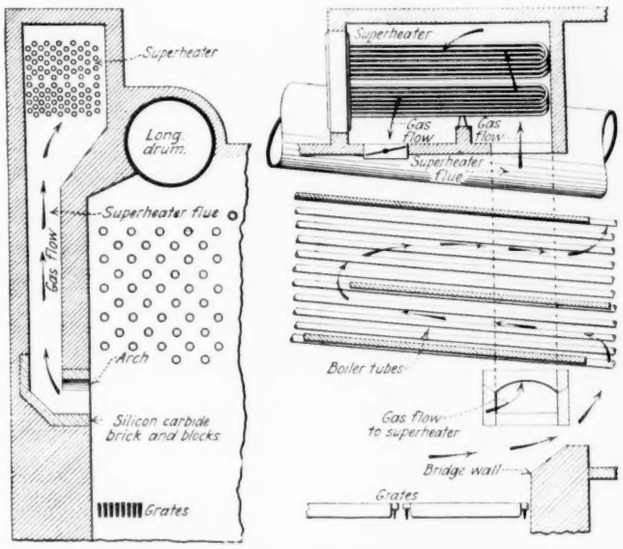
Rosedale, L. I.

[The usual method of gaging the air gap on an induction motor is with a steel strip similar to that shown (exaggerated) in the illustration. A gage of this kind is generally furnished with the motor, but if this is not done, it is advisable to make one while the motor is new or before any appreciable wear in the bearings has taken place. The strip is ground to a thickness of a few thousandths of an inch less than the air-gap width. When it is possible to slip the gage between the rotor and stator at any point, the clearance is within safe limits, but when it is impossible to slip it through at certain points, such as in the direction of belt pull or on the bottom, the necessary steps should be taken to restore the air-gap clearance to a safe value.—Editor.]

## Slagging of Superheater Flues Lessened by Changing Brickwork

The steam-generating equipment in our plant consists of three 5,160-sq.ft. boilers set in a single battery. Each boiler has a superheater placed in a small brick room adjacent to and above the longitudinal steam drums, the average superheat obtained being around 100 deg. F. The gases are conveyed to the superheater by means of flues built into the side walls of each setting. These flues extend from the firebox to the heater chamber as shown in the illustration, and another flue leads from this chamber to the uptake. This arrangement causes a part of the products of combustion to bypass the boiler tubes and pass through the superheater chamber.

We have always had trouble from clinkers sticking to the firebox entrance to the superheater flues. The




*Arrangement of special brick at opening of gas flue to superheater*

flues were in such a position that they could not be reached from the firedoors or any other openings in the setting. To get at them, the boiler had to be taken off the line and the slag knocked out with bars. When the boilers were forced and a poor grade of coal was being burned, the flues would plug up in about two weeks. This, of course, lowered the superheat. In an

endeavor to overcome this condition we experimented with silicon-carbide brick. The firebrick arch and all the other brick at the flue entrance were removed and silicon-carbide arch blocks and brick put in their place. This was tried out in one flue, and the other in the opposite wall was left with firebrick arches and firebrick back and sides. This was to be the control flue.

The boiler was fired up and kept on the line for five weeks. As there was still about 60 deg. superheat in the steam coming from this unit, it was evident that some gas was still passing over the superheater. On inspection it was easy to see on which flue the brick had been changed. The flue built of firebrick was nearly closed with clinker, while the flue composed of silicon-carbide brick had little clinker adhering to it and what little was on the brick was easily removed.

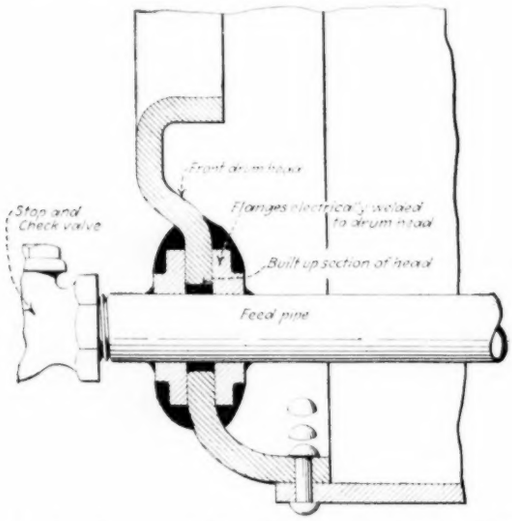
I am aware that no boiler manufacturer places superheaters in this location today. These boilers were erected some years ago, and it was the idea that some others might be having the same trouble that prompted me to relate my experience with this peculiar type of setting.

R. C. WHITEHEAD.

Monroe, N. Y.

## Repairing the Damage from Electrolytic Action with the Electric Welder

A short time after taking charge of a boiler plant consisting of two horizontal water-tube boilers, the joint between the boiler and the feed stop and check valve began to leak. Investigation showed that there was an electrolytic action going on within the boiler. The opening in the front head for the feed pipe had enlarged considerably, and some of the studs were reduced to about half their original diameter. Examination of the boiler showed that the action had taken place at several points, so we began to look for a means of repairing the damage. We called in an electric welder and had him go over the boiler to see what could be done in the way of building up the several spots in the plate to the original thickness. To restore the drum head at the feed-pipe entrance, he chipped the metal around the opening to get a good welding surface, then built up the metal around the hole until the opening was back to the original diameter. Then he welded an extra-heavy marine-type flange on each side of the head and filled in around the edge of the flanges as shown in the illustration.



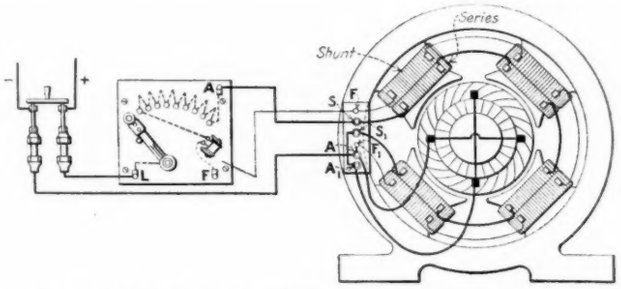

*Drum head was reinforced at feed pipe by welding a flange on each side*

The work was passed by the insurance inspector, who declared it the best job in welding he had ever examined.

Taunton, Mass. BLAINE EMERY.

## Fields in Opposition on Compound Motor Causes Peculiar Operation

Compound motors connected so that the series winding is in opposition to the shunt may develop any one of a number of effects, depending upon the turns in the series winding and the amount and nature of the load on the motor. In one case a motor driving a large tumbling barrel in a factory was reported to vary its speed automatically with the position of the barrel in its revolution. The motor was found to be very hot and sparking badly at the commutator. When the load was being lifted in the barrel the motor would speed up and when the load dropped it would slow down. It was suggested that the electrician interchange the series-field connections, as the two field windings were probably opposing. After this was done, the motor operated normally and revolved at practically nameplate speed.




*Shunt field open to test polarity of series winding*

With the two fields in opposition, when the load increased on the motor during the short period of lifting the material in the barrel, the increased current through the series winding would weaken the field and tend to increase the speed of the motor. When the material in the barrel tumbled, the load was reduced on the motor and the decrease in current in the series winding allowed the field strength to be increased by the shunt winding, and the motor slowed down. Thus the speed of the motor varies with the revolutions of the barrel in an opposite direction to what it should, since, when the heavy load comes on the motor, it should have slowed down.

If there is any doubt about the operation of a compound motor, the polarity of the field windings should be tested. This can be easily done, by first slowly bringing the motor up to speed as a compound machine, without load. Then shut the motor down and disconnect the shunt winding at the starter, as in the figure, and then try starting the motor as a series machine. If the two field windings are of the same polarity, the armature should rotate in the same direction in both cases. If it reverses its direction with the series field only connected, this will show that the two field windings are in opposition and the leads of the series winding should be interchanged. In making this test, the starting resistance should not be cut out of circuit when running on the series winding, or the motor will race.

Baldwinsville, N. Y. ANTHONY J. CHRISTOPHER.

# Comments from Readers

## Some Uses for Thermometers

In *Power* for Feb. 8, on page 208, J. R. Belknap says that a well installed thermometer is far more reliable for measuring vacuum than the usual layout of mercury gage and barometer. He says that a great number of errors are bypassed, but recognizes that there is an increased time lag in cases of sudden changes.

This is bad medicine. It is difficult to install a thermometer that will indicate the *steam* temperature. It is much more likely to indicate something closer to the temperature of metal wall through which it is inserted, and this temperature is influenced by conduction of heat from the hot end of the turbine and by radiation to the outside air. I have myself seen a thermometer that indicated a superheat of 30 deg. F. in the exhaust from a condensing turbine. Impossible, of course, and yet this thermometer was an elaborate electric resistance device 20 or 30 ft. long, installed with a view to securing a dependable average of the steam temperature. But it was located near the metal walls of the turbine exhaust casing, which was found to be considerably hotter than the steam.

It is probably true that *if* a thermometer could be placed so as to respond accurately to *steam* temperature, its indications would be reliable, and obviously it could be read more easily than the combination of vacuum gage and barometer, with their admitted vagaries. But on the whole I incline to believe that it is easier to overcome the gage difficulties than to find an appropriate location for a thermometer in a place where it is physically possible to put the thermometer.

Incidentally, the A.S.M.E. Test Code for Steam Turbines requires that exhaust pressure shall never be computed from temperature observations.

New York City. JAMES A. HARRIS.

## Is Smoke Abatement Practically Possible?

Theoretically, smoke abatement is completely possible. Practically, it is incompletely possible under present conditions. Some day it will probably be entirely possible.

The smoke nuisance, outside of incorrect application of air for combustion, is largely caused by excess volatile content in coals and ignorance of the methods for securing smokeless combustion on the part of the coal users. The users of small amounts of coal cannot prevent soft coals from producing smoke to some extent, and many small smoke producers in the aggregate cause smoke-contaminated atmospheres. Also, atmospheric moistures and changes in barometric pressures are unavoidable causes. Why does not the National Bureau of Mines stop the nuisance?

A possible remedy that may be applied comprises the following details:

1. Producing low-cost fuel gas from low-cost high-volatile bituminous coals and using such gas more generally. Gas for this purpose can be made at a cost of from one-half to one-third of that of the gas that is generally made and used in cities today. Excepting in large cities having greatly congested populations, the general use of fuel gas by the small householder is in my opinion, economically possible, not only for cooking, but also for heating. Substantially everybody can burn gas without producing smoke.

2. Transform low-cost high-volatile crude fuels into solid fuels that are relatively smokeless. Such transformed coals can be cheaply produced and generally easily burned without smoke if stoked by trained firemen. Prepared fuels that contain solid soft-coal constituents will always produce some smoke in their burning, but such smoke can be burned before it escapes into the atmosphere, by a proper intermixture with air over the fuel bed. Even crude low-volatile soft coals can be coked on the fuel bed by careful stoking and frequent or continuous feeding of the soft fuel, if the right kind of fuel-burning device is used.

3. Schools might be instituted for the practical training of combustion overseers in the relatively few practical details required to direct furnace attendants how to burn fuels economically and smokelessly. Dissemination of such practical information through personal instruction will go a long way toward securing smokeless combustion, as well as securing economy in the general use of fuel.

4. A heavy fine could be imposed on any large coal consumer who can afford to employ a trained stoker, if his chimney is emitting smoke. It will abundantly pay any large coal consumer to employ trained firemen to fire his furnaces or operate the stokers so as to avoid the escape of smoke from the combustion space. The use of properly prepared fuels should reduce the cost of heating from one-third to one-half at least. In large cities where fuel gas conduits of adequate size are not practical, it will be found that the economical heating of large buildings will be through the use of prepared fuels having as a thermic base low-cost high-volatile soft coals.

5. Let the small coal user burn anthracite or properly graded coke with or without enrichment with anthracite fines. It is quite easy to crush coke and use the crushed product for small domestic cooking and heating purposes, the saving of labor more than compensating the cost of such smokeless fuels by the small user.

6. By banking heating furnaces with a properly prepared smokeless low-cost banking fuel at the hour of retiring, which will reduce the rate of combustion during the sleeping hours and thus prevent the fuel bed being burned out at the rising hour and requiring large fuel replenishment. This practice should cut down the cost of heating throughout all coal-burning communities at least 15 per cent.

7. By a reduction in the fuel cost of the electric current so that the current can be much more widely used in the large cities by small users both for cooking and heating. Such use will, of course, be of advantage to

the user as well as helpful in securing smoke abatement.

Patents have been issued covering the idea of impregnating coke with low-cost fuel oils to use as enriching constituents of gas-producing fuels. Latest information points to the possibility through such use and otherwise, of largely cutting down the cost of fuel gases; and inasmuch as all such low-cost gases either of producer or water-gas character can be enriched to any desired degree with cheap fuel oils, there is no good reason why the extended use of fuel gas for heating, as well as for generating power under some circumstances, should not be expected, with consequent reduction of the smoke nuisance. All such advances point to the elimination of the smoke nuisance, and in some cases in many communities an immediate elimination if proper action is taken. J. M. W. KITCHEN.

East Orange, N. J.

## Why Short Flame Travel Reduces Furnace Volume

The contribution by Guy B. Randell in the Jan. 18 issue on "Why Short Flame Travel Reduces Furnace Volume" is of extraordinary interest, as it points out to the engineering profession a vast field of opportunity for future achievements.

Mr. Randall emphasizes that the definite knowledge concerning the burning of pulverized fuel is extremely limited; he also states that in at least one commercial installation sound waves have a visible effect on combustion. Just how much accelerating action such waves would have in the case of an installation designed to secure the optimum of such effect remains to be seen. Mr. Randall has thus brought to our attention a most important aspect relative to pulverized fuel burning, which is not visible in furnaces burning coal by the long-flame process.

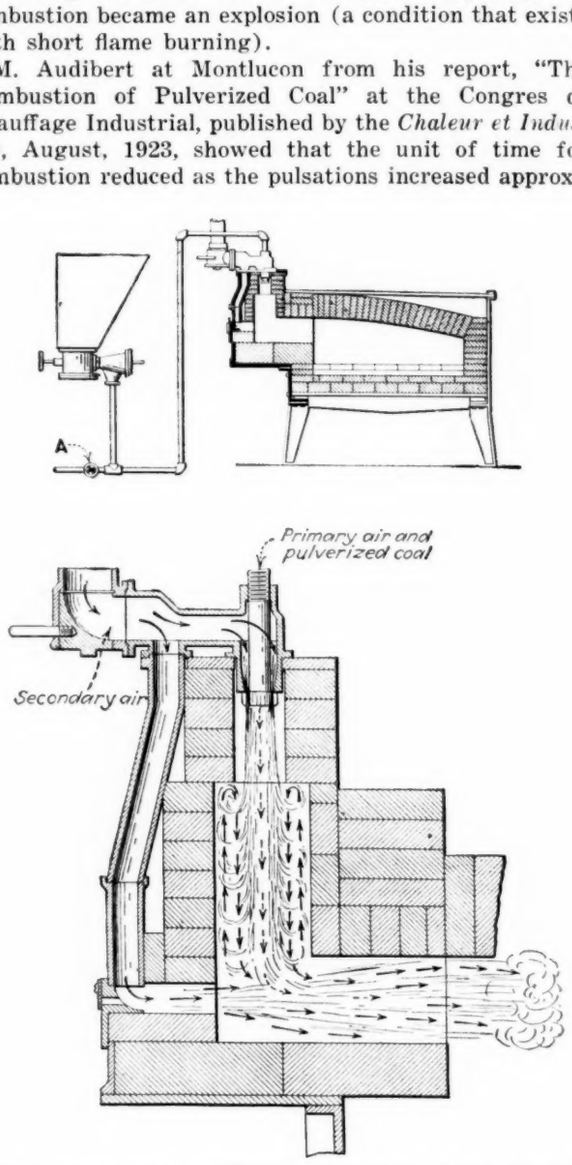
To have a correct idea of powdered coal burning let us first consider a tiny piece of coal, suspended in air and not acted upon by gravity, or both coal and air at rest in constant volume, pressure and high temperature of atmosphere.

The combustion will begin on all the faces of the coal, and immediately the coal will be separated from the surrounding air by a layer of ash and unburned gases, when the coal will smolder and cease to burn. This result will be the same if an element of coal is entrained in a current of air, all moving at the same velocity in the same direction, which to a degree is the action produced by the long flame travel. It is obvious that for combustion to continue the air must come in contact with the coal. The velocity of combustion depends not only on the quantity of air and nature of combustible, but also the speed of contact per unit of time. Sound and vibration accelerate the speed of contact, producing short flame.

It is admitted that combustion is practically instantaneous the moment an element of air comes in contact with an element of combustible. This is true only so far as the quantity air surrounding the piece of coal. Obviously the sudden combustion causes an expansion in the gases, causing a pulsation which shakes off ash from the coal and draws in a charge of air, thus creating air currents which again brush away ash and burnt gas strata.

M. Taffanel and M. Audibert made experiments burning pulverized coal in a tube and found that the velocity of combustion was uniform so far as the oscillating movements, the frequency of which were compatible with the characteristics of the tube, and that when this oscillating movement became of higher frequency, the combustion became an explosion (a condition that exists with short flame burning).

M. Audibert at Montlucon from his report, "The Combustion of Pulverized Coal" at the Congres de Chauffage Industrial, published by the *Chaleur et Industry*, August, 1923, showed that the unit of time for combustion reduced as the pulsations increased approximately as follows: 15 per cent at 700 pulsations per minute; 35 per cent at 1,100; 50 per cent at 2,100.




*One of the early applications of short-flame burning*

It is obvious that furnace volumes can be reduced 15 to 35 per cent and even 50 per cent with short flame burning having rapid pulsations.

M. Roszack has said that when the flame is short the fuel particles burn at high temperature, which would destroy the brickwork if the flame should be directed against it; but precisely because the flame is short, it is easily localized and the trajectory controlled. The shorter the flame the more easily directed.

Sound has an apparent effect on combustion and will serve as an indicator for regulating furnace conditions. When burning fuel at the rate of 500,000 B.t.u. per cu.ft. per hour, the combustion emits a sing or hum. At least this is the case with a furnace arrangement shown in the illustration. After the fuel and air sup-

ply was regulated, the burning conditions were entirely controlled according to the tone, sing or hum caused by the combustion, the regulation of which was accomplished by valve *A*, which supplied primary air from transporting and projecting the pulverized fuel into the chamber at the desired velocity.

Too slow a velocity or too much coal entering the chamber caused pulsations and tones of low note. Correct velocity and supply of coal were indicated by high vibrations and a tone of high note. With too high a velocity or too much air, vibrations ceased and no sound was emitted other than that produced by the movement of air.

It is apparent that the observations of Randall, Audibert, Taffanel and Roszack are of considerable importance, as pulsations and vibrations increase with the emission of sound. The flame becomes relatively shorter and loses all flame aspects with a tone of high note.

New York City. J. GOULD COUTANT.

## Who Is to Blame?

Recently, I had an opportunity to visit a newly constructed public building on "open house" day, and the chief interest to me was the power and heating system. One of the outstanding features of this building was the advertised absolutely modern conveniences. And as far as the features in direct relation to the uses of the building (hospital) were concerned, they seemed to be O.K., but somebody made a bad slip in the design of the power and heating system.

The power house was equipped with locomotive-type boilers, arranged to burn natural gas only, whereas they were originally designed to burn a good grade of lignite coal on a down-draft water-tube grate. There were no feed-water heaters, feed pumps, meters, $CO_2$ instruments, thermometers or gages, except those necessary on the boilers. There was an expensive blowoff tank arrangement, which in my opinion need not have been so elaborate and the saving might well have been spent in instruments.

The condensate return was fed to the boilers by means of two tilting traps, one receiving the return from the various return lines at the low level of the pipe tunnel and discharging into the second trap located near the ceiling. This one in turn discharged into the boilers by gravity in the usual way. Here again, it seems to me, was an added expense and complication that could have been avoided.

The boilers were to operate at about 80 lb. gage. The heating mains were supplied through reducing valves, and no use was made of the high-pressure steam except for sterilization, cooking, etc. Couldn't some use be made of this pressure drop? All the electrical energy, refrigeration, etc., are bought on the open market. The whole plant is located in a basement whose floor is about five feet below the sewer level. Off in one corner is a steam-operated ejector for cellar draining. I am wondering what would happen if some accident should put the ejector out of commission and cause the plant to be flooded.

It should be remembered that this is not an old plant, but a new one—one that is yet to see service. Who is responsible for conditions such as this? Is it the architect, the installer, the contractor or the building directors? Surely, we cannot place the blame on any one of them.

In this particular case the architect has a state-wide reputation, the contractor has been noted, locally, for his good workmanship, the sub-contractor who installed the equipment is considered reliable, and at least one of the building committee should have known better.

Although I consider this is a glaring exception and not the rule, undoubtedly many similar examples could be found. In this enlightened age there is seemingly no excuse for such expensive misconceptions of what someone calls a power and heating system.

As I have had several years' experience in institutional work of this nature, the shortcomings of this particular plant were readily apparent. Will building owners ever learn that the selection and location of the power and heat producing equipment is just as important a factor as the design of the building itself. Frequently, the power house spells the difference between profit and loss, the balance is so close. Why not make it the best with the funds available, and not place in a lot of equipment that is not used or is ill-adapted to its intended use?

Let us hope that there will soon be an end to such installations. I do not believe all the operating mishaps should be charged against the engineer, who generally has nothing to do with the laying out or the original installation of the equipment. He has troubles enough to keep such a layout in operation, although he should set about to improve them as soon as he can. K. R. GIDDINGS.

Billings, Mont.

## The Power Plant Is *Not* so Bad

Much discussion has been centered around the question of conditions and wages in the power plant. Many have declared that the game is not worth the candle and have gone into other work. I reached the same conclusion and found work elsewhere.

After an absence of six months I am again "back home"; that is, I have re-entered the power field, having accepted my old position, which I left some six months ago to earn higher wages.

The higher wages were good, very good, while they lasted—but a slack period put an end to that.

To appreciate his position in most any capacity in a power plant, a man needs only to leave it for a while and enter some vocation where conditions are not so desirable.

Possibly I am fortunate in having employment in a plant where conditions are more or less ideal, and I do not doubt that the environment is not so pleasant in all plants. But I have learned, and I think my case is similar to many others, that the man who is conscientious with himself and his employer cannot find the same contentment elsewhere.

Of course, I refer to men that are in the game, and I realize that other trades or professions appeal the same to those who have selected one of these trades for their life work.

To the man who is now employed in a power plant at reasonable pay and who is contemplating entering another trade that pays a higher hourly rate but is affected by the trend of building growth or by climatic conditions or frequent industrial depressions, all of which invariably hit the tradesmen and shop men before they touch the power plant, I would say simply that the change may prove disastrous.

Pittsburgh, Pa. J. W. GRUNDY.

# Boiler Feed Water Abstracts

FOR some time a "Joint Research Committee on Boiler Feed-Water Studies" has been investigating water treatment, scale, corrosion, priming and foaming, etc., from the viewpoint of steam-station and railroad practice. The work is being carried on under the auspices of the American Society for Testing Materials, the American Water Works Association, the National Electric Light Association, the American Railway Engineering Association and the American Society of Mechanical Engineers. The organization consists of an Advisory and Editing Committee, of which Sheppard T. Powell is chairman, and nine subcommittees, each intrusted with some technical division of the work.

Subcommittee No. 9, under the chairmanship of Prof. George Stetson, is responsible for the preparation of the bibliography. This is to consist of items selected by the regular editorial staff of the *Engineering Index* and such additions as come to the attention of the committee. The material is issued monthly through the courtesy of the A.S.M.E. main research committee. The following items were selected from the first two reports of the bibliography subcommittee.

### Boiler Feed Water

*Analysis*—Composition of Water and Injurious Constituents It Contains (Composition des eaux naturelles et elements nuisibles qu'elles peuvent contenir), J. Guth. *Assns. Francaises de Propriétaires d'Appareils à Vapeur*—Bul. No. 25, July, 1926, pp. 161-180, 3 figs. Discusses chemical constituents of water and importance of accurate analysis; gases, minerals and organic compounds; water hardness, temporary and permanent; typical feed-water analysis.

*Conditioning*—Boiler Water Conditioning with Special Reference to High Operating Pressure and Corrosion, R. E. Hall. *Combustion*, Vol. 15, No. 3, Sept., 1926, pp. 156-159, 1 fig. Scope of boiler-water conditioning; prevention of scale formation on evaporating surfaces; relation between chemical used in treatment and operating pressure; control of non-condensable gases in steam by conditioning of boiler water.

*Dissolved Oxygen Recorder*—Recorder for Dissolved Oxygen in Feed Water. *Engineering*, Vol. 122, No. 3174, Nov. 12, 1926, p. 610, 2 figs. Instrument, known as Cambridge dissolved-oxygen recorder, gives continuous record of quantity of oxygen present in feed water on chart calibrated in cubic centimeters per liter so that defects in feed system which might otherwise remain unnoticed for long periods, may be instantly detected and remedied.

*Evaporating* — The Treatment of Boiler Feed Water by Means of Evaporators (Die Aufbereitung des Speisewassers für Dampfkessel mittels Verdampferanlagen), Wintermeyer. *Feuerungstechnik*, Vol. 14, No. 22, Aug. 15, 1926, pp. 263-266, 2 figs. Disadvantages of chemical treatment; degassing of feed water; preparation of feed water by evaporation, whereby condensate and distillate are precipitated as feed water; examples of modern evaporator plants; cooling-water evaporators.

*Foaming and Priming* — Present Knowledge of Foaming and Priming of Boiler Water, with Suggestions for Research, C. W. Foulk. *Mechanical Engineering*, Vol. 48, No. 11a, Mid-Nov., 1926, pp. 1364-1367. Progress report of Subcommittee No. 3 on Zeolite Softeners, Internal Treatment, Priming and Foaming, and Electrolytic Scale Prevention.

*Impurities* — Water and Its Impurities, J. C. Moore. *Power House*, Vol. 20, No. 17, Sept. 5, 1926, pp. 17-19. Effect of impurities in feed water of boilers is to cause deposition of scale on interior of water-heating surfaces, in addition to deposition of mud or sediment, thus facilitating corrosion and foaming; corrosion results mainly from use of hard water; causes of hard water; how deposit becomes hard; carbonates of magnesia; alkalinity of water; test for calcium salts; treatment to prevent scale; water filtration.

*Municipal Water Supply*—Municipal Water Supplies and Effect of Trade Wastes in Relation to the Use of Water in Power-Plant Practice, V. B. Siems. *Mechanical Engineering*, Vol. 48, No. 11a, Mid-Nov., 1926, pp. 1372-1373. Progress report of Subcommittee No. 7 on Municipal Water Supply in Relation to Boiler Use.

*Preheating Pump*, E. Josse. *Engineering Progress*, Vol. 7, No. 8, Aug., 1926, pp. 208-209, 3 figs. Details of pump manufactured by firm of F. Seiffert and Co., Berlin, novel feature of which is that boiler feed water is heated inside pump in direct contact with bleeder steam, pump raising pressure of condensate of prime movers fed back to boilers, from condenser pressure to boiler pressure.

*Pretreatment of Boiler Feed Water*, C. R. Knowles. *Mechanical Engineering*, Vol. 48, No. 11a. Mid-Nov., 1926, pp. 1361-1363. Progress report of Subcommittee No. 2 on Water Softening by Chemicals (External Treatment).

*Treatment of Feed Water* — Natl. Elec. Light Assn.—Report, No. 256-71, July 1926, 30 pp., 21 figs. Results in several plants with use of sodium aluminate as accelerator in outside treating systems, and experience with acid-treating apparatus used in connection with zeolite system; scale troubles in interdeck and radiant-heat-type superheaters; boiler-scale troubles in high-pressure plant, which has been endeavoring to maintain suggested sulphate-carbonate ratio; caustic-embrittlement troubles with boilers at Long Beach steam plant of Southern California Edison Co.; acid treatment of boiler water as developed by Dallas Power & Light Co.

*Treatment* — The Preservation of Boilers and Condensers from Incrustation and Corrosion by Means of Electric Current, J. Frankfurt. *Electritchestvo*, No. 7, July, 1926, pp. 315-318, 5 figs. Review of methods of water purification used in boiler feeding and employed in Russia and other countries. (In Russian.)

### Boiler Operation

*Load Determination* — Measuring Boiler Load Without Flow Meters, J. D. Jenkins. *Power*, Vol. 64, No. 18, Nov. 2, 1926, p. 658. Author makes use of principle that what comes in minus what goes out must equal what stays; this principle is applied to dissolved solids in water entering boiler; from analysis of feed and boiler waters and knowledge of time boiler has been on and quantity of blowdown, evaporation can be calculated.

### Boiler Plate

*Embrittlement* — Concentration of Caustic Soda in Joints between Boiler Plate (Laugenkonzentrationen in Verbindungen von Kesselblechen), R. Baumann. *Archiv für Wärmewirtschaft u. Dampfkesselwesen*, Vol. 7, No. 9, Sept., 1926, pp. 255-260, 16 figs. Results of investigation carried out for German Union of Boiler Users, showing that supposed concentration of salts, especially of caustic soda, in rivet seams is possible only if seams are leaking and feed water is very salty.

*Embrittlement*—The Cause and Prevention of Embrittlement of Boiler Plate, S. W. Parr and F. G. Straub. *University of Illinois Bulletin*, Vol. 23, No. 42, June 23, 1926, p. 7062, 50 figs. Concludes that embrittlement is caused by combined action of stress and chemical attack; stresses are inherent in construction and in operation of boiler, whereas chemical attack is caused by sodium hydroxide in boiler water; certain methods of water treatment tend to convert some safe waters into characteristic type of water which produces embrittlement; presence of sodium sulphate in feed water and undecomposed sodium carbonate in boiler water tends to retard embrittling effect of carbonate waters; methods for introducing sulphates in boiler waters have been worked out to point of practical application. Bibliography and data from embrittled boilers.

### Boilers—Corrosion and Scale Preventive

*Corrosion*—Boiler Corrosion on the Canadian Pacific Railway, T. W. Lowe. *Boiler Maker*, Vol. 26, No. 8, Aug., 1926, pp. 223-226. Report on paper entitled "Boiler Fitting and Corrosion," presented at Master Boiler Makers' Association.

The Problem of Steam-Boiler Corrosion, F. N. Speller. *Mechanical Engineering*, Vol. 48, No. 10, Oct., 1926, pp. 1017-1023, 2 figs. Mechanism of corrosion; boiler feed water; dissolved oxygen and $CO_2$; salt, alkali and acid content; influence of scale, organic matter, and composition of materials of construction; preventive measures; general precautions for care of boilers.

*Scale Prevention*—Overcoming Scale in Boilers, D. Cochrane. *Power House*, Vol. 20, No. 20, Oct. 20, 1926, pp. 15-16. Author shows some causes of scale formation and outlines various methods to overcome its effects, dealing particularly with troubles caused when oil and scale combine in boiler.

The Prevention of the Formation of Boiler Scale. *Engineering*, Vol. 122, No. 3168, Oct. 1, 1926, pp. 415-416, 5 figs. Water-cooled type of apparatus known as "filtrator," which is now being used to prevent formation of boiler scale for removal of old deposits; process consists in introducing water-soluble constituent of linseed into water which is fed into boiler in such a way that no oil enters with it; with new modification, old trouble has been entirely eliminated; details of other modifications.

### Steam Condensers

*Tube-Scaling Tools*—Condenser Tube Scaling Tools. *Engineering*, Vol. 122, No. 3174, Nov. 12, 1926, pp. 611, 2 figs. Describes tool for removal of condenser scale, which has proved particularly useful in power-station work, where matter of some 8,000 tubes perhaps 17 ft. long, may have to be dealt with.

*Tubes* — Investigation of Strongly Corroded Brass Condenser Tubes (Untersuchungen von Messingkondensatorrohren mit starker Korrosion), M. Schwarz. *Korrosion u. Metallschutz*, Vol. 2, No. 1, Jan., 1926, pp. 8-17, 17 figs. Examination of tubes from two power plants showed basic zinc carbonate in corroded spots, and experiments showed that cooling water attacked beta mixed crystals of brass.

### Locomotive Boilers

*German* — Means of Preventing Boiler Pitting, C. H. Koyl. *Railway & Locomotive Eng.*, Vol. 39, No. 10, Oct., 1926, pp. 278-279. Author shows that it is easier to exclude oxygen from locomotive boiler than from stationary boiler or any closed water system; on districts with treated or naturally soft water there is no difficulty in preventing pitting with present open heater, nor in materially reducing it by closed heater or even with closed-overflow injection properly chosen and properly operated.

*Pitting*—Pitting of Locomotive Boilers, W. A. Pownall. *Ry. Rev.*, Vol. 79, No. 8, Aug. 21, 1926, pp. 263-270, 5 figs. Observations of boiler corrosion in various forms.

### Steel

*Embrittlement* — Embrittlement of Steel, A. G. Christie, *Mechanical Engineering*, Vol. 48, No. 11a, Mid-Nov., 1926, pp. 1368-1372. Review of investigations and opinions on embrittlement of steels used in boilers; Progress report of Subcommittee No. 6 of Joint Research Committee on Boiler Feed Water Studies.

### Water Filtration

*Softened Water*—High-Pressure Filtration of Softened Water, L. H. Biggar. *Power Plant Engineering*, Vol. 30, No. 19, Oct. 1, 1926, pp. 1050-1051, 1 fig. High head, fine clean sand bed of low uniformity and high porosity and removal of deposited solids give clear filtered water.

# Voltage Standardization a Live Topic at A.I.E.E. Convention

AT THE Winter Convention of the American Institute of Electrical Engineers, held in the Engineering Societies Building, New York City, Feb. 7 to 11, a symposium of eight papers was presented on voltage standardization. The papers were arranged to present the views of various branches of the electrical industry which are the most interested in voltage standardization for alternating-current supply systems. These papers were prepared by representatives of the operating companies from various sections of the country, consulting and management interests, European engineers and American electrical manufacturers.

In the papers various systems of voltage standards were proposed. In presenting the manufacturers' side of the question, F. C. Hanker and H. R. Summerhayes suggested a system of standards for step-down transformers secondary voltages from 115 to 69,000 volts, which is in multiples of 11.5, excepting transformers supplying 2,400-volt systems, which will be rated at 2,400 volts. For voltages higher than 69,000, transformers are to have secondary voltages in multiples of 11, complying with well established practice. Step-up transformers, excepting the 2,400-volt class, are to have their high-tension windings rated in multiples of 11.5 up to 69,000 and in multiples of 11 above that voltage, whereas the low-tension windings will be rated 5 per cent lower than the system voltages or generator voltages. These step-up and step-down transformers will not be interchangeable.

Existing standards of voltages have not been closely followed, according to R. E. Argersinger, in a paper presenting the consulting engineer's viewpoint, because the operating companies in general have given too little consideration to simplifying their requirement, and in designing for standardization the manufacturers have placed too much emphasis on cost reduction and have paid too little attention to flexibility of use. A system of standard voltages is proposed that differs somewhat from those offered by the manufacturers' representatives, and it is also proposed that step-up and step-down transformers be made interchangeable by 5 per cent taps above and below the rated voltage in each winding.

The discussion on the various papers clearly indicated that there is a wide diversity of opinion on what a standard system of voltages should be and how to arrive at such standards, although generally agreeing that simplification and unification of power-system voltages is desirable for all interests, the manufacturers, the power companies and the consumers. It was generally agreed that the utilization voltage was the focal point about which a standard system of voltages should be developed. It was announced that a line of 200-volt motors was soon to be placed on the market that would allow the use of a 115- and 199-volt, 4-wire, three-phase system for light and power.

Attention was called to the gain there had been made in standardizing electric lamps. At one time in this country there were over 50,000 different kinds of commercial lamps in use, where today there are only 54 for general lighting purposes, and future developments promise to reduce these to 18. As an illustration of the conditions in this country and Europe with regard to lamp standards, it was told that in one instance at Vienna in a lamp stock of 3,000,000, the greatest number of any one kind was 3,000, where in this country a similar stock would contain 198,000 of one kind.

It was said that if national standards are required, then international standards are also necessary. The European situation respecting voltage standards is in a much worse condition than in this country. Europe is making an effort to bring order out of its voltage and frequency chaos, and the opinion was expressed that it was worthy of our effort to try to see if something could not be done to bring about international standards.

Lamp voltages attracted considerable attention as a basis of any system of voltage standards. At the present time a very large percentage of all lamps sold for commercial and residential lighting are for 110, 115 or 120 volts, with the 115-volt class representing about 50 per cent of the total. For this reason it was felt that these three voltages should be included in the basis of working out a standard voltage system.

Variation in voltage on the power system appeared to be an important factor in developing a system of standard voltages. At the present time a great deal of equipment is being worked at considerably above rated voltage to meet these conditions. It was thought all right to standardize on utilization voltages, but the supply apparatus should be designed to suit these standards.

# Recent Publications

**Die Luftvorwärmung im Dampfkesselbetrieb.** (Air Preheating in Steam Boiler Practice.) By Wilhelm Gumz. Published by Otto Spamer, Leipzig LI, Germany, 1927. 177 pages; 89 illustrations; 18 tables. Price, paper binding, 10 marks; cloth, 12 marks.

This book contains chapters on the following subjects: Fuels, combustion, combustion temperature, the influence of temperature on combustion, boiler efficiency, difficulties in the use of preheated air, special types of boiler construction for high preheat temperatures, types of air preheaters, application of preheaters, experimental data, summary.

**Hydro-Electric Handbook.** By William P. Creager, Chief Engineer, The Power Corporation of New York, and Joel D. Justin, Hydraulic Engineer, U.G.I. Contracting Co. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City, 1927. Semi-flexible binding; 6x9 in.; 897 pages; 494 illustrations; 93 tables. Price, $8.

During the last fifteen years water-power engineering has been practically revolutionized. Multiple-runner units have been replaced by the single-runner types, and the horizontal-shaft type has been superseded by the vertical-shaft machine. In low-head developments high specific speeds have become the order of the day, and a number of new types of such wheels have been developed and are in successful operation in important developments. Draft-tube design has gone through radical changes, and many other inovations have been introduced that had no part in water-power development a few years ago. The economic side of the problem has also become a dominating factor in both the design and the operation of such projects.

Out of these many changes there has come a demand for a new literature on water power, and during the last few years a number of books have been produced which include various phases of these modern developments. In this handbook the authors have presented a compendium of all phases of water-power development. It begins with a chapter on rainfall, then follows through the various phases of such developments and ends with a chapter on the operation of hydro-electric properties.

The first eight, of a total of thirty-five chapters, deal with that essential element in all water-power projects, a water supply. These include rainfall, factors affecting run-off, stream flow, flood control, storage and power available. Precipitation and run-off maps of the United States are included. Among the nineteen tables is one giving the drainage area and the flood flow for a large number of the rivers in the United States. In the chapter on hydraulics a great deal of attention has been given to the losses in conduits and other factors affecting flow.

In the three chapters on dams the designs of nine different types have been considered and many references are made to practical examples of these designs. The various types of gates and methods of handling them, valves, conduit intakes, spillways, fishways, sluices, trash-rack rakes and provisions against ice have been treated in two chapters. Six chapters are devoted to as many types of conduits and the accessories that are associated with their use, with specifications for fabricated steel and wood-stave pipe. Much space has been given to the general design of water-power developments, the power house, wheel settings and the selection and purchase of equipment. Electrical design and transmission lines have been covered in 140 pages. A chapter on investigations and reports adds materially to making the work a comprehensive treatment on water-power developments.

The two authors under whose names the book appears and the nine others who assisted them are practicing engineers, responsible in many cases, for the design, construction and operation of large water-power properties. It is the thinking of such engineers that the book represents. The authors have brought together a vast amount of information in an easily accessible form, and their efforts should fill a long-felt need in water-power literature.

**Water-Power Engineering.** By H. K. Barrows, Professor of Hydraulic Engineering, Massachusetts Institute of Technology, and Consulting Hydraulic Engineer. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Cloth; 9x6½ in.; 306 illustrations; 117 tables; 734 pages. Price, $6.

Low-cost fuel and radical improvements in steam power stations have made it more difficult for water power to compete on an economic basis with the steam plant. This condition, along with the development of an economic consciousness among hydraulic engineers that there is something more in the development of water power than putting a wheel in a setting and opening the gate for the water to flow, have brought about the consideration of a large number of factors that a few years ago did not enter into the picture of water power. It is from this broad economic viewpoint that the author has presented the subject.

The work has been divided into 12 chapters and 4 appendices: Water-power development — its distribution and use; hydrology; study of stream-flow data and water-power estimates; hydraulic turbines and general arrangement of plants; dams; waterways, canals and penstocks; power house and equipment—hydraulic and structural; power house and equipment—electrical; plant accessories; speed and pressure regulation; transmission lines; cost and value of water power; reports and plant descriptions; hydro-electric development—outline; report upon Red River power development; and plant descriptions and problems.

In the opening chapter a concise picture is given of the water powers of the world, their distribution and the extent of their development. One of the basic elements in water-power development is river and stream flow, and this involves a thorough knowledge of hydrology, which has to do with the occurrence and distribution of water over and within the earth's surface. To this and its companion subject, stream-flow data and water-power estimates, 145 pages have been devoted. The volume of stream flow depends upon precipitation and its disposal. This subject has been given an interesting treatment.

During the last 15 years there have been many changes in the design of waterwheels and their settings. These the author has discussed at considerable length and he compares the older type of units, with as many as three runners on a vertical shaft and six on a horizontal shaft, with the vertical single high-speed runners of modern design. Testing of hydraulic turbines and the general arrangement of water-power developments are also given attention in the chapter on turbines.

Factors affecting location and cost of dams, investigation of dam and reservoir sites, types of dams and their design are among the features included in the chapter on dams. In presenting the subjects of waterways, canals and penstocks, numerous examples of designs and their costs are given. A table is included which gives the hydraulic properties and other features of 14 canals. Another table deals in a similar manner with 14 penstocks.

In the chapters on power house and equipment and plant accessories the details of design of a number of different structures have been given, with tables of detailed data on various types of plants. One of these tables has the detailed information on 47 different plants. A chapter is included on the cost and value of water power, which gives the costs of developing a number of typical power sites and shows how the economic value of such projects is affected by load factor, cost of steam power, etc.

Considerable space has been given to the electrical features of the power house and to transmission lines. Although these sections contain valuable data for those who may be interested in these subjects, the hydraulic engineer may feel that this space could better have been devoted to matters more closely associated with the hydraulic features of water-power plant design and operation. However, the author has brought together a wealth of data on water-power development and has presented it in an easily read manner. The book has been written primarily as a text for engineering students, but as the author is a practicing engineer as well as a college professor, the practical side of engineering has been kept in mind in the presentation, and the book should find a wide field of usefulness among those interested in water-power development.

# News in the Field of Power

## San Joaquin Light & Power Opens Balch Plant

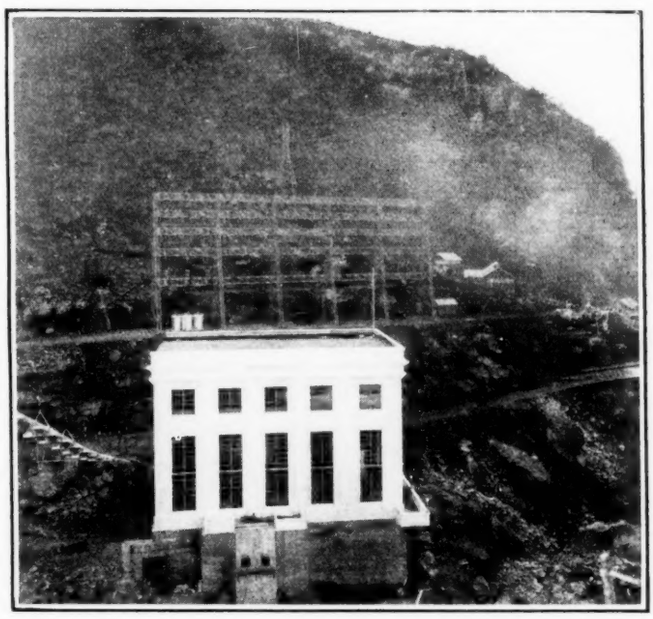
With dedicatory ceremonies the Balch hydro-electric plant of the San Joaquin Light & Power Corp., located on the North Fork of the Kings River, about fifty miles East of Fresno, Calif., was placed in service on Jan. 29.

A gathering of approximately five hundred representing engineers, editors, business men and the general public of the San Joaquin Valley were guests of the company at a luncheon served at the power plant at noon. This was followed by a brief program presided over by Henry Hawson, vice-president of the Fresno County Chamber of Commerce. A. Emory Wishon, vice-president and general manager of the San Joaquin Light & Power Corp. and the Great Western Power Co., of California, paid a tribute to H. K. Fox and his construction organization for having completed the plant at a saving of half a million dollars under the estimated cost of $3,674,000.

A. C. Balch, after whom the plant was named and A. G. Wishon, president of the company, told of the pioneering difficulties in locating hydro-electric plants in the rugged Sierra Nevada Mountains. The electrical industry was likened by Ezra Decoto, chairman of the California Railroad Commission to the fairy tale of Aladdin's lamp. The speaker said that instead of praying to Allah, the people of the San Joaquin Valley should give thanks to the work of Mr. Wishon and Mr. Balch for making available an abundant supply of hydro-electric power for the agriculture and industry of the valley.

The plant was officially placed in operation by the closing of a switch by Mr. Wishon. The power house contains one 33,000-kva. generator driven by two 20,000-hp. impulse waterwheels operating under a static head of 2,381 ft., the highest head of any plant yet to be constructed in this country.

The Balch plant is the first unit in a chain of plants on the Kings River that will eventually develop 495,000 horsepower.



*Balch Plant of the San Joaquin Light & Power Co., Near Fresno, Calif.*

## A.I.S.E.E. Discuss Boiler-House Auxiliary Drives

Electrification of boiler-house auxiliaries was the subject discussed at the Philadelphia Section meeting of the Association of Iron and Steel Electrical Engineers, held in the Philadelphia Engineers' Club, Saturday evening, Feb. 5.

A paper on this subject was presented by F. T. Leilach, of the engineering department, Consolidated Gas, Electric Light & Power Corp. The speaker expressed the opinion that the question of a drive for the boiler house auxiliaries could not be divorced from the type of drive to be used for the rest of the power house. The selection of any kind of a drive is very largely controlled by economic considerations, that is, how much it will cost to produce a kilowatt-hour on the switchboard. Reliability and simplicity are other factors that must be kept in mind when selecting auxiliary drives.

Wherever possible the equipment should be of such a character that it can be dismantled, repaired and put back into service by the power-house attendants, said Mr. Leilach, as this added materially to the successful operation of the plant. No general statement could be made as to which type of equipment was the best suited to driving power-house auxiliaries, he declared, since the selection was influenced by many factors, among them the increase in steam pressures and temperatures. The increase in reliability and flexibility of electric motors and control has had a big influence in applying electric drive to auxiliaries.

### Control of Motor Drives

The general adoption of the regenerative heat cycle and the tendency to eliminate small steam piping about the plant has been another factor. The high economy of the large turbine has made it desirable to carry as much of the station load as possible on these units. This has influenced the design of the small turbine and the efficiency of these machines has been making a steady advance upward.

Selecting control equipment for power-house motor drives was the center of considerable discussion, and the general opinion expressed was to the effect that the standard type of apparatus used in industrial service was not suited to many of the power-plant applications. The equipment being located so close to the source of power, was subjected to a more severe service in case of trouble, than it would be out on the line. On the essential auxiliaries the kind of protection given the equipment is such that it may be, at times of trouble, subjected to very heavy currents. Reliability of the equipment is also a factor of greater importance than in many industrial applications.

### Voltage of Auxiliary Service

The choice of a voltage for auxiliary service also attracted considerable attention. Some of those present were inclined toward the use of 2,300 volts, except for motors under 50-hp. capacity, where others favored a 440-volt power supply and others felt that 230 volts should be used, unless the uninsulated 440-volt parts were not to be exposed to those unfamiliar with such apparatus. The dividing line of costs of such equipment was given as around 125-hp. motor sizes. Below this size 440-volt equipment was found to be cheaper when the cost of all apparatus was included. The cost of the 2,300-volt installation is less when the motor sizes are above 125-hp. This figure will vary somewhat with the type of motor and installation, but 125 hp. is probably a good average value.

## Prof. Moore "Salts" Old Notions on Fatigue of Metals

That engineers must take the so called "fundamentals" of the mechanics of materials with a grain of salt if they would hope to understand fatigue of metals phenomena was the outstanding impression left by Prof. H. F. Moore in a lecture delivered in Hartford, Conn., on Feb. 8.

Under the joint auspices of local sections of the A.S.M.E. and the American Society for Steel Treating, more than one hundred and fifty engineers listened to the speaker, who is research professor of engineering materials at the University of Illinois and an international authority on the subject of metallic fatigue.

Professor Moore showed that the so called "elastic limit" (a term having no accepted precise meaning) was practically useless as an index of ability to withstand repeated stresses. It was shown that the ultimate tensile strength is a far better measure of fatigue resistance. Blind use of textbook formulas, the speaker said, leads engineers to overlook the immense importance of proper fillets and the danger from small scratches on machine parts subjected to a great number of repeated stresses. On the subject of combined stress and corrosion, a case was cited where a stream of cooling water passing over a test piece of steel under tension cut the fatigue limit in half.

### Some False Assumptions

The following is a brief digest of some of the more significant portions of Professor Moore's address.

Fatigue failure may be defined as failure under many repetitions of stress. The term does not include failure under a long continued steady load. The cohesion of metals as determined by tensile tests is but a small fraction of what might be deduced from a theoretical study of the mutual attractions of atoms. The difference may be due to the arrangement of the atoms in patterns which lie in various relations to the direction of pull.

The formulas ordinarily used in computations for the strength of machine parts are based on the three assumptions that, first, the material is uniform, second, that it may be subdivided indefinitely without change of properties and, third, that the stress is proportional to the strain within the so called "elastic limit." The first two assumptions are false and the third is only an approximation. Engineers should, therefore, view with suspicion any conclusions deduced from these "fundamentals."

A good example of erroneous conclusions is found in the ordinary method of figuring the unit stress in a bolt under tension. The customary division of the total load by the cross-sectional area at the root of the thread gives the average unit stress, but the localized stress at the root of the threads may easily reach three times this figure if the threads are sharp. This higher stress is the determining element when the load is repeated a great number of times, although the figure for the average stress is useful under steady load.

Once started, the cracks are points of concentrated stress, so that each repetition of the load extends them until failure occurs.

For most ferrous metals the fatigue limit in specimens without sharp corners is about 50 per cent of the ultimate strength and 250 times the Brinell hardness number.

### Urges Corrosion Fatigue Study

The importance of avoiding all sharp re-entrant corners in parts subjected to repeated stress cannot be overemphasized. A crank shaft turned with sharp corners has only about half the operating strength of one with proper fillets. A rough turned turbine disk is notably weaker than a smooth one. A single scratch or tool mark may seriously weaken it.

An important subject upon which more study is needed is that of corrosion fatigue, a problem closely related to the so called "caustic embrittlement" of metals as found in the riveted seams of boiler drums. Recent experiments showed that the strength of a piece of steel under high tension might in some cases be lowered as much as 50 per cent by simply turning a stream of cold water upon it.

The type of machine used at the University of Illinois for determining fatigue limit has already been described in *Power*, but will be outlined briefly for those who may not be familiar with it. The specimen to be tested is turned in the form of a spindle gradually reduced at the center to a fixed diameter. The two ends are attached to shafts turning in self-aligning ball bearings. Two equal weights so suspended from ball bearing collars mounted on the two sides of the reduced section load the specimen as a simple beam.

The specimen is rotated by a motor equipped with a counter and self-stopping device, so that personal attendance is not needed. To make a test a number of similar specimens are required. The first is loaded enough to cause failure in a relatively small number of revolutions. Successive specimens are given smaller and smaller loads and each is spun until it fails. This is continued until a load is obtained which causes no failure within the maximum number of revolutions set for the experiment. When these points are plotted on logarithmic paper, with stress, as ordinates and total revolutions as abscissas, the curve falls steadily to a certain stress and then straightens out quickly to a constant value.

To make sure that the curve continues horizontal a few tests were carried to 1,000 million reversals of stress. This required continuous operation of the machine twenty-four hours a day for four hundred days.

Professor Moore's lecture was illustrated with lantern slides and with "micro movies" showing pieces of metal failing under stress.

The erroneous assumptions mentioned gained general recognition because the mechanics of materials was first applied by civil engineers to such structures as bridges, where the variation in stress is smaller and less frequent than in machines.

The old notion that fatigued metal crystallizes was long ago discarded. The microscope shows that metals are always crystalline. Another exploded idea is that the "elastic limit" as determined by tensile tests is the stress at which metals will fail under repeated load.

There seems to be no fixed relation between elastic limit and the "fatigue limit." The latter is the minimum stress which, reversed a great number of times (say 100,000,000 times), will cause failure. This has been determined for many samples by tests made at the University of Illinois and generally settles down to a constant value for any number of reversals beyond ten million and in some cases as low as two million.

The elastic limit if defined as the limit of true proportionally between stress and strain, is highly indefinite. The closer the measurements, the lower is the value obtained, leading to the suspicion that the true elastic limit may be found only at zero stress.

## Heine Boiler Co. Bought by International Combustion

The International Combustion Engineering Corp. officially announced Feb. 10, the acquisition of the capital stock of the Heine Boiler Co., one of the oldest and leading water-tube boiler manufacturers in the United States. This acquisition gives the International Combustion Engineering Corp. large boiler shop facilities at St. Louis, Mo. and Phoenixville, Pa.

All types of water-tube boilers will be manufactured at St. Louis including the new sinuous-header type recently placed on the market. The manufacture of the Ladd water-tube boilers and the new combustion steam generators will also be centered in the St. Louis plant.

The acquisition of the Heine company will enable the International Combustion Engineering Corp. to furnish to its customers complete generating units fired with pulverized fuel or mechanical stokers, all of its own manufacture. It is understood that this new acquisition requires no financing by the International Combustion Engineering Corp., the Heine Co. having been acquired through a cash payment.

C. R. D. Meier will remain as president of the Heine Boiler Co.

## E. D. Adams Deeds Fund to United Engineering Society

For the establishment of a fund, the income from which is to be divided equally between the Engineering Foundation Board and the Library Board, of the United Engineering Society, Edward Dean Adams, mechanical engineer, scientist and financier, gave, through W. L. Saunders, president of the Society, a personal gift of $100,000, Jan. 20.

Mr. Adams was the recipient of the John Fritz Gold Medal of 1926, awarded in recognition "for great achievements as engineer, scientist, whose vision, courage and industry made possible the birth at Niagara Falls of hydro-electric power."

## Large Condensers Ordered for State Line Generating Co.

Eight condensers for the State Line Generating Co., Commonwealth Edison Co., for use in connection with a 208,000 kw. triple turbine unit consisting of one high pressure and two low pressure turbines will be built by the Allis-Chalmers Manufacturing Co.

The two low pressure turbines are each double flow and two condensers are required for each set of low pressure wheels, making four condensers for each low pressure turbine or eight condensers in all.

Each of the condensers will contain 22,000 sq.ft. of effective cooling surface. They will be designed to handle 1,600,000 lb. of steam per hour and supplied with 360,000 g.p.m. circulating water from four vertical circulating pumps placed in a crib house located outside the generating station. The condensers are of the vertical single pass type; the circulating water entering through the lower water box, passing through the condenser tubes and then being discharged through overflow pipes contained in the condenser shell. This arrangement eliminates unsightly circulating water piping, as with the usual standard arrangement the discharge piping would be placed outside of the condenser in the turbine room.

## Decision on Shoals Offers Now Seems Unlikely

An effort to secure congressional action on a revised offer of the American Cyanamid Co. for Muscle Shoals has encountered difficulties in the Military Affairs Committee of the House of Representatives.

At the present time there is great doubt whether the new bill will reach the House calendar. The consensus of opinion on Capitol Hill seems to be that neither this bill nor the offer of the Associated Power Companies, which was reported favorably by the Joint Committee appointed by the Senate and the House, will be voted on finally in the three weeks remaining of this Congress.

## Fitkin To Supply Bethlehem Steel Plant With Power

A. E. Fitkin & Co. announce that the Bethlehem Steel Co. has signed a $1,500,000 power contract for their Coatesville, Pa., plant, with the Chester Valley Electric Co., a unit of the Municipal Service Co., which is a subsidiary of National Public Service Corp. of the Fitkin Utility System. Contract calls for 12,000 hp. of connected load for a period of five years.

## Coal Output in 1926 Put at 663,290,000 Tons

Coal produced in the United States during 1926 amounted to 663,290,000 tons, the Bureau of Mines reports, revealing that the total was exceeded only in 1918 when war demand was at its peak, and the output was 678,211,000 tons. Of the 1926 production, 578,290,000 tons was bituminous coal and 85,000,000 anthracite.

## Survey Shows Upward Saving in Power Coal Consumption

Efficiency in the utilization of fuels by electric public-utility power plants throughout the United States has shown a remarkable increase in the few years since the World War, according to a report of engineers of the Geological Survey of the Interior Department, made public Jan. 14.

This efficiency was forced primarily by the large advance in the cost of fuel brought about by the war and the continuance of the high costs in general during the intervening period. In summary, the report follows:

"The electric utilities were faced by a public opinion which was hostile to any increase in rates, and on this account no relief could be obtained through appeal to the public-utility commissions. The power companies were therefore forced to seek methods of reducing costs of operation, and they soon found a broad field for such reduction in the better utilization of fuels, which had been representing more than 80 per cent of operating costs. From 1919 to 1925 they have shown an increase of efficiency in the average utilization of fuel amounting to 52 per cent, as measured by the average number of kilowatt-hours generated by the consumption of a ton of coal, with the result that electricity is one commodity in common use which is costing the consumer less now than before the war.

### Efficiency Steadily Growing

"Improvement in design and increase in size of plants, interconnection, and increase and betterment of load have all helped to reduce the fuel rate, but the spur back of all these improvements was the increased cost of fuel that threatened profits. The average consumption of coal per kilowatt-hour of electricity in 1925 was about 2.1 pounds.

"The efficiency of the utilization of oil and gas for fuels in the production of electricity well illustrates the operation of the law of supply and demand. In some sections of the country where oil and gas are abundant and therefore relatively cheap, the average quantity of these fuels used in generating a unit of electricity is large, but in sections where these fuels are not produced and their cost includes transportation charges their utilization is more efficient.

### Kilowatt-hour with 14,000 B.T.U.

"During 1926 the best coal-burning plants have produced a kilowatt-hour of electricity with about one pound of coal, and at the same time gas- and oil-burning plants have been built that produce a kilowatt-hour with about 13 cu.ft. of gas and between 425 and 450 kw.-hr. to the barrel of oil. These figures mean that a kilowatt-hour of electricity is now being produced with about 14,000 B.t.u. by the use of each of the three fuels—coal, oil and gas—an accomplishment which of course should always have been possible and probably would have been attained except for the abundance and consequent relative cheapness of oil and gas in the regions where they are locally consumed."

## Canada Shows Steady Growth in Power Industry

Capitalization of the electric light and power industry of the Dominion of Canada has now reached $700,000,000, according to a statement issued to the Royal Bank of Canada.

Attention is drawn to the fact that the Dominion Water Power and Reclamation Service has estimated that during the next twenty years the expenditure for new installations will exceed one billion dollars. The fact that the total capacity of the turbines now installed is double the capacity of 1915, and that the recent rate of construction is much more rapid than the rate at the beginning of the period, both indicate that this is a conservative estimate.

In the first eleven months of 1926 the average daily production of electric energy for Canadian consumption exceeded the production during the same period in the previous year by 23.8 per cent.

## Obituary

**Dr. Charles Doolittle Walcott,** secretary and executive head of the Smithsonian Institution, and recognized as one of the world's greatest scientists, died at his home in Washington, D. C., Feb. 9, of apoplexy. Dr. Walcott would have been seventy-seven years old on March 31. He had been seriously ill for a week. From geology and palaeontology to aviation was the range of Dr. Walcott's scientific interests. In 1888 he took charge of invertebrate palaeontology, in 1891 became chief palaeontologist, and in 1893 was placed in charge of both geology and palaeontology. Finally, in 1894, he succeeded Major J. W. Powell as director of the Geological Survey. Meanwhile he was placed in general charge of palaeontology in the United States National Museum and served there until 1897, when he became acting assistant secretary of the Smithsonian Institution in general charge, and in 1907, secretary. He was secretary of the Carnegie Institution in 1902-05, vice-chairman of its trustees and since 1917 chairman of its executive committee.

**Henry Bradford Sargent,** president and general manager of the Sargent Hardware Co., New Haven, Conn., past vice-president of the American Society of Mechanical Engineers, died in a New Haven Hospital after a short illness, Feb. 3.

Mr. Sargent, who was in his seventy-seventh year, entered Sheffield Scientific School in 1869, graduating in 1871. He early showed a strong inclination for the mechanical field and followed his father's footsteps in the hardware line, becoming president of the Sargent Hardware Co., which was established by his father, in 1918.

Vice-president of the A.S.M.E. from 1918-1920, Mr. Sargent was also for many years a trustee of Yale University and served on many committees. He was a director of the New Haven Bank.

## Personal Mention

**John Cogan**, formerly assistant engineer for R. H. Macy & Co., New York City, is now assistant manager in charge of mechanical operation.

**David Lewis Fiske**, formerly of the department of mechanical engineering, University of Illinois, has been appointed assistant secretary of the American Society of Refrigerating Engineers.

**Harold W. Smith**, mechanical engineer, was recently promoted from the general engineering department of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Pa., to the managership of the generating apparatus sales department.

**Edgar J. Kates**, consulting engineer, 203 West 13th St., New York City, has published a booklet which tells the buyer and the user of oil engines how they can profit from the engineering assistance of an independent oil-engine specialist.

**C. F. Hirshfeld**, chief of research department of the Detroit Edison Co., **P. W. Thompson**, chief assistant engineer of power plants, and **Sam Dean**, electrical engineer, sail for Europe March 12 to meet engineers and visit power plants in England, Germany, France, Switzerland, Belgium.

**David J. Kerr**, superintendent of power for the Champion Fibre Co., Canton, N. C., was appointed honorary vice-president of the American Society of Mechanical Engineers by President Charles M. Schwab to represent the Society at the eighth annual meeting of the Associated General Contractors of America, which was held in Asheville, N. C., Jan. 24-27.

**Sherman F. Jeter**, chief engineer of the Hartford Steam Boiler Inspection & Insurance Co., has been elected vice-president of the company. Former Vice-President William R. C. Corson has been promoted to the presidency and President Charles S. Blake becomes Chairman of the Board. Mr. Jeter is prominent in engineering circles having been vice-president of the American Society of Mechanical Engineers, and an active member of its Boiler Code and other committees.

## Society Affairs

**The Florida Engineering Society** will hold jointly with the Florida Section of the A.S.M.E. its annual meeting at Clermont, Fla., March 21 and 22.

**The Affiliated Technical Societies of Boston** will hold an industrial production and transportation meeting with morning and afternoon sessions at Huntington Hall, 491 Boylston St., Boston, Feb. 17. In the afternoon "The Economics of Electrification" will be the topic of an illustrated lecture by Sidney Withington, electrical engineer, N. Y., N. H. & H. R.R., New Haven, Conn. The annual engineers' dinner at the New Chamber of Commerce Building, under the auspices of the societies, will follow the afternoon's sessions.

## Coming Conventions

**American Institute of Electrical Engineers.** F. L. Hutchinson, secretary, 33 West 39th St., New York City. Kansas City, Mo. regional meeting March 17-18, Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

**American Society of Civil Engineers.** George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

**American Society of Mechanical Engineers.** Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman of the Kansas City Section.

**American Water Works Association.** W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

**American Welding Society.** Annual meeting at 29 West 39th St., New York City, April 27-28-29.

**Chicago Power Show**, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

**Engineering Institute of Canada.** Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting which was held at Montreal on Thursday, Jan. 27, was adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

**Heating and Ventilating Exposition.** Will be held at Twelfth Regiment Armory, New York City, March 14-19 inclusive.

**Midwest Power Conference**, at Chicago, Feb. 15-18. Sessions will be held in the Coliseum concurrently with the Chicago Power Show; G. E. Pfisterer, secretary.

**National Association of Stationary Engineers**—Annual convention, in conjunction with the Pacific Coast Power Show, will be held at the Ambassador Hotel, Los Angeles, Calif., Aug. 22-27 inclusive, John Topman, secretary, convention committee. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention at Anderson, May 27-28; George S. Billman, secretary.

**National Board of Boiler and Pressure Vessel Inspectors.** Annual meeting at Nashville, Tenn., during second week of June.

**National Electric Light Association.** A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

**National Marine Engineers' Beneficial Association.** Fifty-second annual convention at the Hotel Franklin Square, Washington, D. C., Feb. 14-19. Albert L. Jones, secretary-treasurer.

**Universal Craftsmen Council of Engineers.** Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

An illustrated talk on "Air Conditioning in General with Special Reference to Industrial Plants" will be given by a representative of the Carrier Engineering Corp., at dinner at the Boston City Club, Feb. 16. W. S. Maddocks, 147 Milk St., is secretary.

## Fuel Prices

### COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

| Bituminous Net Tons | Market Quoting | Feb. 7 1927 |
|---|---|---|
| Pool 1 | New York | $3.00@$3.25 |
| Smokeless | Boston | 2.17 |
| Clearfield | Boston | 2.00@ 2.40 |
| Somerset | Boston | 2.10@ 2.50 |
| Kanawha | Columbus | 1.40@ 1.75 |
| Hocking | Columbus | 1.75@ 2.00 |
| Pittsburgh | Pittsburgh | 1.90@ 2.00 |
| Pittsburgh gas slack | Pittsburgh | 1.40@ 1.50 |
| Franklin, Ill. | Chicago | 2.50@ 2.75 |
| Central, Ill. | Chicago | 2.00@ 2.25 |
| Ind. 4th Vein | Chicago | 2.25@ 2.50 |
| West Ky. | Louisville | 1.25@ 1.60 |
| S. E. Ky. | Louisville | 1.60@ 2.00 |
| Big Seam | Birmingham | 1.50@ 2.00 |
| **Anthracite** Gross Tons | | |
| Buckwheat No. 1. | New York | 3.00@ 4.50 |
| Buckwheat No. 1. | Philadelphia | 2.50@ 4.50 |
| Birdseye | New York | 1.60@ 2.00 |

### FUEL OIL

**New York**—Feb. 10, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

**St. Louis**—Jan. 31, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 6.2c. per gal; 38@40 deg., 7c. per gal.

**Pittsburgh**—Feb. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 6⅞c. per gal.

**Philadelphia**—Feb. 2, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.725@$1.785 per bbl.

**Cincinnati**—Feb. 7, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

**Chicago**—Feb. 7, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.75.

**Boston**—Feb. 7, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¾c. per gal; 28@32 deg., 6c. per gal.

**Dallas**—Jan. 29, f.o.b. local refinery, 26@30 deg., $1.73 per bbl.

## Business Notes

**The McLain-Simpers Organization**, operating in the handling of market examinations, sales analyses, advertising, Stock Exchange Building, Philadelphia, Pa., has recently announced that it has taken over the account of the Protex-A-Motor Manufacturing Co., Pittston, Pa., in the manufacturing field of gasoline filters.

**The Dampney Company of America,** manufacturers of protective coatings for metal surfaces, has recently opened up a branch sales office in the Bourse Building, Philadelphia, with C. J. Hunter in charge.

**The Walker Vehicle Co.,** an Illinois corporation owned by the Commonwealth Edison Co., Chicago, has recently acquired substantial control of the Automatic Transportation Co., Inc., Buffalo, N. Y.

**The Air Preheater Corp.,** 25 Broadway, New York City, announces that G. O. French has joined its organization in the capacity of New York and eastern sales manager. Mr. French has for the last ten years been associated with the New York office of the Walsh & Weidner Boiler Company.

**The Eastern Texas Electric Company of Delaware,** a subsidiary of the Engineers Public Service Co., has purchased the Nebraska Electric Power Co. which serves some twenty-five towns in central and northwestern Nebraska and maintains power stations in Loup City, Broken Bow, Cozad, Lexington and Gordon. The Nebraska Electric Power Co. will be under the executive management of Stone & Webster, Inc., and will be operated from Scottsbluff, Nebraska.

**The Kennedy Valve Manufacturing Co.** marks this year as its fiftieth anniversary. The business was founded in 1877 by Daniel Kennedy, who is still the president and in active charge of the Kennedy organization. This unusually long and uninterrupted continuity of ownership and management has been an important factor in the steady development and growth of the Kennedy business. The Kennedy line covers a large range of valves and pipe fittings for standard and special requirements in central power stations, water works, fire protection systems, industrial plants, hotels and office buildings throughout the country.

## Trade Catalogs

**Control Relays**—The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., devotes bulletin L-2033-A to the description of control relays, giving the first information printed on the type 30-C and 40-C relays.

**Tachometers**—The American Schaeffer & Budenberg Corp., 338 Berry St., Brooklyn, N. Y., in a new catalog, No. 500, covers all types of stationary, recording and portable tachometers for indicating and recording speeds directly in r.p.m. or f.p.m. An actual sample chart for type 523 recording tachometer is inserted. The catalog is illustrated throughout with installation photographs.

**Oil Circuit-Breakers**—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has issued leaflet L-3969-B covering types E-8, E-9, E-16 and E-17 oil circuit-breakers. Application, operation and construction are discussed, illustrated by several outline drawings and halftones.

**Annunciating Indicators and Signal Equipment**—Chas. Cory & Son, Inc., 183-7 Varick St., New York, are now distributing their new bulletin No. 60-29-A, which describes annunciators, bells, buzzers, and signal equipment. The equipment illustrated in this bulletin shows scientific designing and development of manually and automatically operated visible and audible signals for all routine communication requirements. Comprising, as it does, annunciating indicators, and audible signals for marine and industrial purposes, with a special section devoted to central-station annunciators, this handy reference bulletin presents a complete collection of data and illustrations.

# New Plant Construction

**Calif., Coronado**—Island City Hotel Co., awarded contract for the construction of a 6 story hotel at Orange Ave. and Ada St. to Central States Construction Co., 1107 4th Ave., Huntington, W. Va. Estimated cost $900,000. Steam heating system, elevators, etc. will be installed.

**Calif., Los Angeles**—W. H. Anderson, c/o Kinne & Westerhouse Black Bldg., Contrs. awarded contract for the construction of a 12 story hotel at 553 South Grand Ave. Estimated cost $700,000. Steam heating system, elevators, etc. will be installed.

**Calif., Pittsburg**—P. & J. Helm, plan the construction of an ice plant at Southern Pacific R.R. Estimated cost $40,000.

**Conn., Hartford**—Hartford Electric Light Co., T. H. Soren V. Pres., 266 Pearl St., plans the construction of addition to electric power plant including mercury boilers and turbines, etc. on South Meadow St. Estimated cost $40,000.

**Conn., New Britain**—New Britain Gas Light Co., 23 West Main St., had plans prepared for the construction of a gas generator and blower room. Estimated cost $10,000. M. Unkelbach, 52 Main St., is architect.

**Fla., Jacksonville**—St. Vincents Hospital awarded contract for the construction of a 5 story hospital including power house, etc., at Baros and St. John Sts., to G. W. Hessler. Estimated cost $800,000.

**Ill., Chicago**—Johnston Bros., 77 West Washington St., will soon receive bids for the construction of an 8 story apartment including steam heating system at 6927 Grandon Ave. Estimated cost $1,000,000. R. S. De Goyler & Co., 307 North Michigan Ave., are architects.

**Ill., Chicago**—Sanitary District of Chicago, 910 South Michigan Ave., will soon receive bids for the superstructure of pumping station, also for four 13,500 g.p.m. sewage return pumps, heating plant equipment, etc. Contract for substructure awarded.

**Ind., Bridgeport**—Marion County Tuberculosis Assn., A. Henry, Pres. Building Committee, 720 Hume-Mansur St., is having preliminary plans prepared for the construction of a hospital including central heating plant, etc. Estimated cost $170,000. Donald Graham, 1126 Hume-Mansur St., is architect.

**La., Crowley**—City plans an election Mar. 8 to vote $65,000 bonds for improvements to electric light plant including a 600 hp. Diesel engine, etc.

**Md., Frederick**—Hood College, awarded contract for the construction of a boiler house, etc. to L. C. Culler. Estimated cost $45,000.

**Mass., Cambridge** (Boston P.O.)—H. F. Stimpson, 10 Temple St., awarded contract for the construction of a boiler house and warehouse to Scully Co., 288 Main St.

**Mass., Nantucket**—Citizens Gas, Electric & Power Co., 56 Main St., is having plans prepared for the construction of addition to plant on Crosby Pl. Private plans.

**Mass., Needham** (Boston P. O.)—Edison Electric Illuminating Co., 39 Boylston St., Boston, awarded contract for the construction of an electric station on Chestnut St. here, to W. H. Bailey Co., 88 Broad St., Boston. Estimated cost $40,000.

**Mass., Salem**—Salem Electric Co., will soon award contract for the construction of addition to switch house on Lafayette St. Estimated cost $40,000. Chas. H. Tenney & Co., 200 Devonshire St., Boston, are engineers.

**Mich., Detroit**—Detroit Properties Co., 810 Bagley Ave., awarded contract for the construction of a 18 story theatre and office building including steam heating system, elevators, etc. to Walbridge Alldinger Co., 2356 Penobscot Bldg. Estimated cost $6,000,000.

**Mich., South Haven**—D. Lipsey, 316 South Wabash Ave., will soon award contract for the construction of a hotel including steam heating system. Estimated cost $500,000. Cobb & Eisenberg, 5 North La Salle St., are architects.

**Miss., Perkinston**—Bd. of Trustees of Harrison-Stone Jackson County Agricultural High School and Junior College, C. C. Swetman, Secy. will soon award contract for the construction of a group of buildings including power plant, two boilers, vertical engine, three pumps, hot water and fire pumps, two generators, etc. Harkness & Lockyer, Gulfport, are architects. R. E. Gurley, Mobile, Ala., is consulting engineer.

**Mo., Columbia** — Bd. of Education will receive bids about Apr. 1 for the construction of a heating and ventilating plant for Hickman Senior High School. Estimated cost $60,000. W. B. Ittner, 911 Locust St., St. Louis, is architect.

**Mo., Manchester**—St. Louis County Ice & Cold Storage Co., 9237 Manchester Ave., Maplewood, will soon receive bids for the construction of an ice and cold storage plant here. Estimated cost $40,000.

**Mo., St. Louis**—Bd. of Public Service, 208 City Hall, will receive bids in March for the construction of a municipal service building including central heating plant, etc., on Clark St. Estimated cost $960,000. Study & Farrar, Arcade Bldg., are architects.

**Mo., St. Louis** — Missouri Pacific R.R., Railway Exchange Bldg., will soon receive bids on general contract for a 22 story office building including power plant, five boilers, three electric generators, ten elevators, etc. Estimated cost $2,000,000. M. Tucker, c/o owner, and Mauren, Russell & Crowell, Chemical Bldg., are architects. E. A. Hadley is chief engineer.

**Neb., Crete**—City, C. E. Beals, Clk, will receive bids until Feb. 19 for the construction of a power plant including 100 hp. and 1,300 hp. oil engines direct con-

nected to 375 kva. and 312 kva. generators. Estimated cost 74,900. H. A. Davis, is engineer.

**N. J., Florham Park**—Borough Council, J. T. Welsh, Clk., will receive bids until Feb. 23, for the construction of a deep well pumping station including, well, pump, motor, 100,000 gal. tank on tower, etc. C. Potts, 30 Church St., New York, N. Y., is consulting engineer.

**N. Y., New York**—V. Green Co., c/o E. Roth, 1440 Broadway, is having plans prepared for the construction of a 15 story hotel including steam heating system, elevators, etc., at 105-109 East 21st St. Estimated cost $1,000,000.

**N. Y., New York**—M. Greenberg, c/o G. & E. Blum, 415 Lexington Ave., Archts. and Engrs., is having plans prepared for the construction of a 21 story hotel including steam heating system, elevators, etc. at 227 West 45th St. Estimated cost $3,500,000.

**N. Y., New York**—Lutheran Hospital, A. J. Shoneke, 343 Convent Ave., had plans prepared for the construction of a 5 story hospital including steam heating system, etc. at 181st St. and Bennett Ave. Estimated cost $1,000,000. Crow, Lewis & Wick, 200 5th Ave., are architects.

**N. Y., New York**—D. P. Robinson, 125 East 46th St., will build a 14 story apartment including steam heating system, elevators, etc. at Park Ave. and 75th St. Estimated cost $2,000,000. Private plans. Work will be done by separate contract under the owner's supervision.

**N. Y., New York**—Sis Bros. Inc., c/o Sugarman & Berger, 345 Madison Ave., Archts., is having plans prepared for the construction of a 15 story apartment including steam heating system, elevators, etc. at Central Park W. and 86th St. Estimated cost $1,400,000.

**N. Y., Raybrook**—Dept. of Charities, Capitol, Albany, will receive bids in May for the construction of a power house for State Hospital for the Treatment of Incipient Pulmonary Tuberculosis here.

**O., Bowling Green** — Bd. of Trustees, Bowling Green State Normal School, plans the construction of a group of buildings including power house, etc. Total estimated cost $886,000.

**O., Cleveland**—Case School of Applied Science, C. S. House, Pres., Euclid Ave. and East Blvd., is having sketches made for the construction of a laboratory. Estimated cost $160,000. Wilbur Watson & Associates, are architects and engineers. A machine for testing building materials, 1,000,000 lb. pressure capacity, hydraulic equipment for pumps, etc. will be required.

**O., Cleveland**—Canfield Oil Co., C. McLean, V. Pres., 3216 East 55th St., plans the construction of a boiler house on East 52nd St. Estimated cost $40,000. Private plans.

**O., Columbus** — City Council is having plans prepared for the construction of a municipal building to house police department, jail, municipal court rooms, police and fire telegraph system, central heating plant, etc. Estimated cost $800,000. R. C. Kempton, 82 West Broad St., is architect.

**Okla., Sharon** — City is having surveys made for the construction of a new waterworks system including well, pump, tank on tower, etc. Estimated cost $180,000. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

**Okla., Healdton** — City voted $65,000 bonds for waterworks improvements including wells, pumping equipment, etc. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

**Pa., Pittsburgh**—Rodgers Sand Co., 1 Wood St., is having preliminary plans prepared for the construction of sand and gravel plant including boiler house, etc. on Ridge Ave. Estimated cost $250,000. Hunting Davis & Dunnello, Century Bldg., are architects.

**Tenn., Nashville** — City H. E. Howse, Mayor, plans to rebuild oil heating plant including heaters, etc. recently destroyed by fire. Estimated cost $25,000. Work will probably be done by day labor.

**Tenn., New Port**—City plans the construction of a hydro-electric plant on the Pigeon River. Estimated cost $200,000. Engineer not selected.

**Texas**—Winter Garden Securities Co., W. B. Bass, Secy. & Treas., Republic Bank Bldg., Dallas, is having plans prepared for developing townsite of Seefeld Switch between Carrizo Springs and Big Wells including ice plant, etc. Total estimated cost $150,000. Private plans. Machinery will be required.

**Tex., Dalhart**—Dalhart Water Co. will soon receive bids for waterworks improvements including pumping equipment, mains, etc. Estimated cost $15,000. Private plans.

**Tex., San Antonio**—City plans the construction of a main sewer line from Sherman St. pumping station to Houston St., etc. Estimated cost $76,800. I. Ewig, is city engineer.

**Tex., San Benito**—Valley Electric & Ice Co., F. C. Ludden, Mgr., plans to expend $3,000,000 for new construction, alterations and improvements to new electric and ice plants. Private plans.

**Va., Rosslyn**—F. J. Hughes, owner of Home Ice Co., is having plans prepared for the construction of an ice plant to replace plant of the Rosslyn Packing Co., recently destroyed by fire. Estimated cost $150,000.

**Wash., Tacoma**—Superior Service Laundry Co., Brotherhood Bank, plans the construction of a laundry including 125 hp. boiler house, etc., at South Ferry St. and Tacoma Way. Estimated cost $150,000. Austin Co., Dexter Horton Bldg., Seattle, is architect and engineer.

**W. Va., White Sulphur Springs**—White Sulphur Springs, Inc., is having plans prepared for the construction of addition to hotel including power house, reservoir, etc. Estimated cost $2,500,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects.

**Wis., Milwaukee** — St. Mary's Hospital, 448 Lake Dr., will soon receive bids for the construction of a 5 story hospital and nurses' home including steam heating system. Estimated cost $500,000. O'Meara & Hills, 1705 Arcade Bldg., St. Louis, Mo., are architects.

**Ont., Belleville**—Canadian National Rys., New Union Station, Toronto, will soon award contract for the construction of a 300 ton coaling plant. Estimated cost $30,000. T. T. Irving is chief engineer. Electrically operated conveying equipment will be required.

**Ont., Toronto**—City plans the construction of a waterworks distribution building including pumping equipment, etc. to serve St. Andrews Market area, also the installation of a low lift pumping plant including electrically driven centrifugal pumps in Ashbridges Bay. Estimated cost $250,000 and $525,000 respectively. R. C. Harris, is engineer.

**Ont., Toronto**—Toronto Hydro Electric System, 225 Yonge St., plans the construction of an electric substation including transformers, switchboards, switching equipment, etc., on Laxton Ave. Estimated cost $150,000. Private plans.

**Que., St. Alban**—Portneuf Power Co., Ltd., Power Bldg., Montreal, had plans prepared for the construction of a 65 x 1300 ft. dam for power development. Estimated cost $450,000. S. Svenningson, Montreal, is engineer.

**Que., Sherbrooke**—City, E. A. Bernard, Pres. of Bd. of Trade, plans the construction of a hydro-electric development on Westbury Basin near here. Estimated cost $500,000.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## Equipment Wanted

**Calif., Presidio** (San Francisco P. O.)—Constructing Quartermaster, Fort Mason, San Francisco, will receive bids until Feb. 28, for the installation of a steam turbine generator and generator panel in power house at Letterman General Hospital here.

**Ill., Chicago**—Sanitary District of Chicago, 910 South Michigan Ave., will soon receive bids for four 13,500 g.p.m. sewage return pumps, heating plant equipment, etc. for proposed pumping station.

**Ind., Indianapolis**—Bd. of School Comr., F. M. Frazer, Bus. Dir., 150 North Meridian St., will receive bids until Feb. 17 for furnishing and installing condensation pumps in schools 41 and 39, also vacuum pumps in schools 11 and 12.

**Mass., Lowell**—L. H. Kilton, 1599 Middlesex St., is in the market for one 5 hp., one 10 hp. and one 35 hp. motors, 220 v. d.c.

**N. Y., Creedmoor** (mail Floral Park)—Dept. of Mental Hygiene, Capitol, Albany, will receive bids until Mar. 2 for refrigeration equipment, etc. for Brooklyn State Hospital here.

**Neb., Crete**—City, C. E. Beals, Clk., will receive bids until Feb. 19 for 400 hp. and 1300 hp. oil engines direct connected to 375 kva. and 312 kva. generators.

**Okla., Seminole**—City, M. McCumber, Mayor, is in the market for a new 50 g.p.m. deep well pump and 10 hp. motor.

**Ont., Toronto**—City plans the installation of a 1,000,000 g.p.d. sand washer pump with electric motor in filtration plant. Estimated cost $7,105. R. C. Harris, City Hall, is engineer.

**Que., Lauzon**—Canada Steamship Lines, Victoria Sq., Montreal, is in the market for turbo generator sets for passenger steamer now under construction.